NATIONAL RESEARCH COUNCIL OF ITALY
INSTITUTE OF MARINE SCIENCES MARINE GEOLOGY SECTION (BOLOGNA)

JOINT RESEARCH PROJECT ”EUROMARGINS”

GEOPHYSICAL, GEOLOGICAL AND OCEANOGRAPHIC SURVEYS IN THE NORTHERN RED SEA

REPORT ON THE MORPHOBATHYMETRIC, MAGNETOMETRIC, OCEANOGRAPHIC, CORING AND DREDGING INVESTIGATIONS DURING CRUISE RS05 ABOARD R/V URANIA

ISMAR-CNR, Bologna
DSC, University of Rome ”La Sapienza”
LDEO, New York
IFREMER, Brest
IFG, University of Kiel
DES, University of Cardiff
SGS, Saudi Geological Survey
SCU, Suez Canal University
GEI and SO.PRO.MAR.
and Egyptian and S.Arabian Observers

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Geophysical, geological and oceanographic surveys in the Northern Red Sea. Report on the morphobathymetric, magnetometric, oceanographic, coring and dredging investigations during cruise RS05 aboard R/V Urania.

by Bonatti E., Bortoluzzi G., Calafato A., Cipriani A., Ferrante V., Ligi M., Lopez Correa M., Redini F., Barabino G., Carminati E., Mitchell N., Sichler B., Schmidt M., Schmitt, Rasul N., Al Nomani S., Bahareth F., Khalil S., Farawati R., Gitto D. and Raspagliosi M.

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Abstract - A summary of methodologies, technical details and ship-board results of a swath bathymetry, geophysical, geological and oceanographical survey in the Northern Red Sea is presented. The cruise utilized the CNR's R/V Urania and investigated the Deeps north of 22N. During the 14 days in the area, detailed, full coverage bathymetry, multichannel and SBP reflection seismic, magnetometric lines, bottom sediment sampling were carried out in the Thetis Deep Area. In addition, multibeam bathymetry, SBP and brine sampling in the Nereus, Oceanographer and Conrad Deeps were accomplished. The samples and data collected in the transitional area of the Northern Red Sea will give an insight on the processes that occured during the transition from a continental to an oceanic rift.

Sommario - Vengono presentati le metodologie e l'insieme dei risultati ottenuti durante una campagna di rilievi batimetrici e geofisici nella zona Nord del M.Rosso. E' stata utilizzata la nave da ricerca R/V Urania del CNR, per indagini nella zona di depressione Thetis e a N del 22N. Si e' ottenuta una mappa batimetrica dettagliata con sistema 'multibeam', sono state fatte indagini di sismica a riflessione multicanale e SBP ad alta risoluzione, sono stati raccolti dati magnetometrici ed e' stato campionato il fondo marino (Thetis) e le brine (Nereus, Oceanographer e Conrad).

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ACRONYMS

ACRONYM	DESCRIPTION	URL-email
CNR	Consiglio Nazionale Delle Ricerche	www.cnr.it
ISMAR	Istituto di Scienze Marine	www.bo.ismar.cnr.it
LDEO	Lamont-Doherty Earth Observatory	www.ldeo.columbia.edu
IFREMER	Inst.Francaise Exploitation Mer	www.ifremer.fr
IFG	Institute for Geosciences Kiel University	www.gpi.uni-kiel.de
DES	Dept.Earth Sciences Cardiff University	www.earth.cardiff.ac.uk/
DSC	Dipartimento Scienze della Terra	www.uniroma1.it
SGS	Saudi Geological Survey	www.sgs.org.sa/
SCU	Suez Canal Univ., Geol.Dept.	www.suez.edu.eg
IAGA	Int.Ass.of Geomagnetism and Aeronomy	www.iugg.org/IAGA/
IGRF	Int.Geomagnetic Reference Field	www.ngdc.noaa.gov/IAGA/vmod/
INTERMAGNET	INTErn.Real-time MAGnetic Obs.NETwork	www.intermagnet.org
SEG	Soc. of Exploration Geophysicists	www.seg.org
UNESCO	United Nations Scient. and cultural org.	www.unesco.org
GPS-DGPS-RTK	Global Positioning System	samadhi.jpl.nasa.gov
DTM	Digital Terrain Model	en.wikipedia.org
GEBCO	General Bathym.Chart Oceans	www.ngdc.noaa.gov/mgg/gebco
SRTM	Shuttle Radar Topogr.Mission	www2.jpl.nasa.gov/srtm/
DIC	Dissolved Inorganic carbon	
ETAAS	Electrothermal Atomic Absorption Spectrophotometer	
FEP	Fluorinated ethylene polypropylene	
ICPAES	Inductively-Coupled Plasma Atomic Emission Spectrometer	
ICPMS	Inductively Coupled Plasma - Mass Spectrometry	
HDPE	High density polyethylene	
MBES	MULTIBEAM ECHOSOUNDER SYSTEM	
MCS	Multichannel Seismic	
REE	Rare Earth Elements	
RSDW	Red Sea Deep Water	
SBP	Sub Bottom Profiling	
XBT	Expendable BathyTermograph	www.sippican.com
RESON	Reson	www.reson.it
COMM-TECH	Communication Technology	www.comm-tec.com
NEPTUNE	Simrad MBES Software	www.kongsberg-simrad.com
CARAIBES	Traiment Cartographique Batimetrie	www.ifremer.fr/dnis_esi
MB-SYSTEM	MB-SYSTEM	www.ldgo.columbia.edu/MB-System
GMT	Generic Mapping Tool	gmt.soest.hawaii.edu/gmt
GNU,GPL	GNU is not Unix,General Pub. License	www.gnu.org

Table 1: Acronyms of Organizations, Manufacturers and Products

HOW TO READ THIS REPORT

Sections 1 and 2 give the introductory and background information, including some technological and scientific issues of the organization and execution of tasks, whereas section 3 summarizes the cruise operations. Section 4 provides the technical aspects that were involved in the data acquisition and processing. Sections 5 and 6 discuss the initial results, the on-going data processing and usage, and give concluding remarks. Some data processing procedures that were used in the production of this report along with additional technical details and data are presented in the Appendix.

ACKNOWLEDGMENTS

Many people contributed to the success of the research cruuise (RS05 *R/V Urania*). Firstly, we wish to thank Captain Emanuele Gentile, the Chief Engineer, the officers and crew members of *R/V Urania* for their professionalism and efforts in assuring the success of the cruise. The project was mainly funded by EU's EUROMARGINS projects, with a substancial amount provided by the Italian CNR for ship time. We are indebted to the ISMAR of Bologna (Dr.M.Ravaioli and P.Dall'Olio), for the continuous effort in resolving the financial and technical problems. Dr. M.Borghini of ISMAR at La Spezia kindly provided the SIPPICAN launcher, while Dr. Manzella of ENEA provided some of the XBT. We thank you both. We also wish to acknowledge Italian Embassies in Egypt and Saudi Arabia for their assistance.

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1 INTRODUCTION

It is generally accepted that the Red Sea and the Gulf Aden rift systems (Fig.1) provide the closest modern anologs to the rifting and rupturing of continental lithoshere that formed the continental passive margins of the Atlantic, Indian and Arctic Oceans. The Red Sea spreading center is believed to have developed within a continental rift following an extended period of rifting, that started in the late Oligocene (30 Ma). The Red Sea continental rift has been mostly extensional and is characterized by the rotation of large crustal blocks such as those exposed in the Gulf of Suez, which initiated as the northern end of the Red Sea during the Late Oligocene-Early Miocene. Most of the extension along the Red Sea was accommodated by sinistral movement along the Gulf of Aqaba-Dead Sea transform that was established in the Middle Miocene, with a second, currently active, phase of movement initiated in the Pliocene ([Bosworth and McClay(2001), Khalil and McClay (2001)].

The development of the spreading centers in the Red Sea varies in magnitude and style along the rift axis. The transition to seafloor spreading is more advanced to the south where the spreading center nucleated near 17N about 5 Ma and propagated both north and south from that location [Cochran (1983), Ghebreab (1998), Bonatti (1985)]. The spreading center axis is continuous south of 21N and it becomes discontinuous northward upto a series of discrete localized centers of intrusion marking where seafloor spreading is nucleating. Thus, the Red Sea shows along-strike all stages involved in the transition from a continental to an oceanic rift.

The project, funded by the EU within the "Euromargins" framework, aimed (a) to clarify tectonic and petrological aspects of the transition from a continental to an oceanic rift and the formation of passive margins, and (b) to address problems of sedimentation in an embryonic ocean and bio-geochemistry in the axial hydrothermal cells. The work at sea would include multibeam, magnetic, gravimetric and seismic reflection surveys, rock and sediment sampling, and water sampling of the axial hydrothermal vents. In addition to processing and interpreting of the geophysical data obtained at sea, a comprehensive analytical program on the geochemistry of igneous rocks and hydrothermal fluids would be undertaken.

The objectives were to study: (1) the northernmost (presumably youngest) troughs with truly "oceanic" crust, and their transition to thinned/stretched continental crust; (2) a fracture zone intersecting the Red Sea (Zabargad Fracture Zone), where the earliest stages in the development of the large oceanic transforms could be observed, and where the north-propagating Red Sea oceanic rift appears to impact at present; (3) the origin and nature of segmentation of the rift axes and offset of the deeps; and (4) the structural architecture of the deeps and the control on localization of the transition zones.

The project also aims to integrate the onshore and offshore data to model the tectonic evolution of the Red Sea rift system. The activities and initial results of the research cruise RS05 in the Northern Red Sea aboard CNR's *R/V Urania* are presented.

To tackle the above specific topics, we decided to focus our field work on the Northern and transitional regions (Fig.2) trying to obtain high resolution morphobathymetric, magnetometric, SBP and Multi Channel Seismic reflection data, other than bottom rock dredges and brine samples for mineralogical, petrographical and geochemical analysis. In order to achieve our objectives focus was placed on the Northern and transitional areas in the Red Sea (Fig.2). A multi-parameter data acquisition scheme was applied in order to optimize the understanding of the rift system. High resolution morphobathymetric, magnetometric, SBP and Multichannel seismic reflection data were obtained, including rock and sediment samples, brine and water samples to carry-out mineralogical, petrographical and geochemical analyses. Time constraints and permission restrictions restrained the research objectives, and therefore focus was placed on Thetis Deep and its transition to Nereus Deep, a zone previously almost uninvestigated, to test the hypotheses of the evolution from continental to oceanic rifting and the northern propagation of the oceanization process. During the transits we also investigated two of the northernmost Red Sea Deeps, the Conrad Deep and the Oceanographer Deep to sample brines, and the Coral Seapeak, a small seamount of probable igneous origin, looking for deep sea corals.

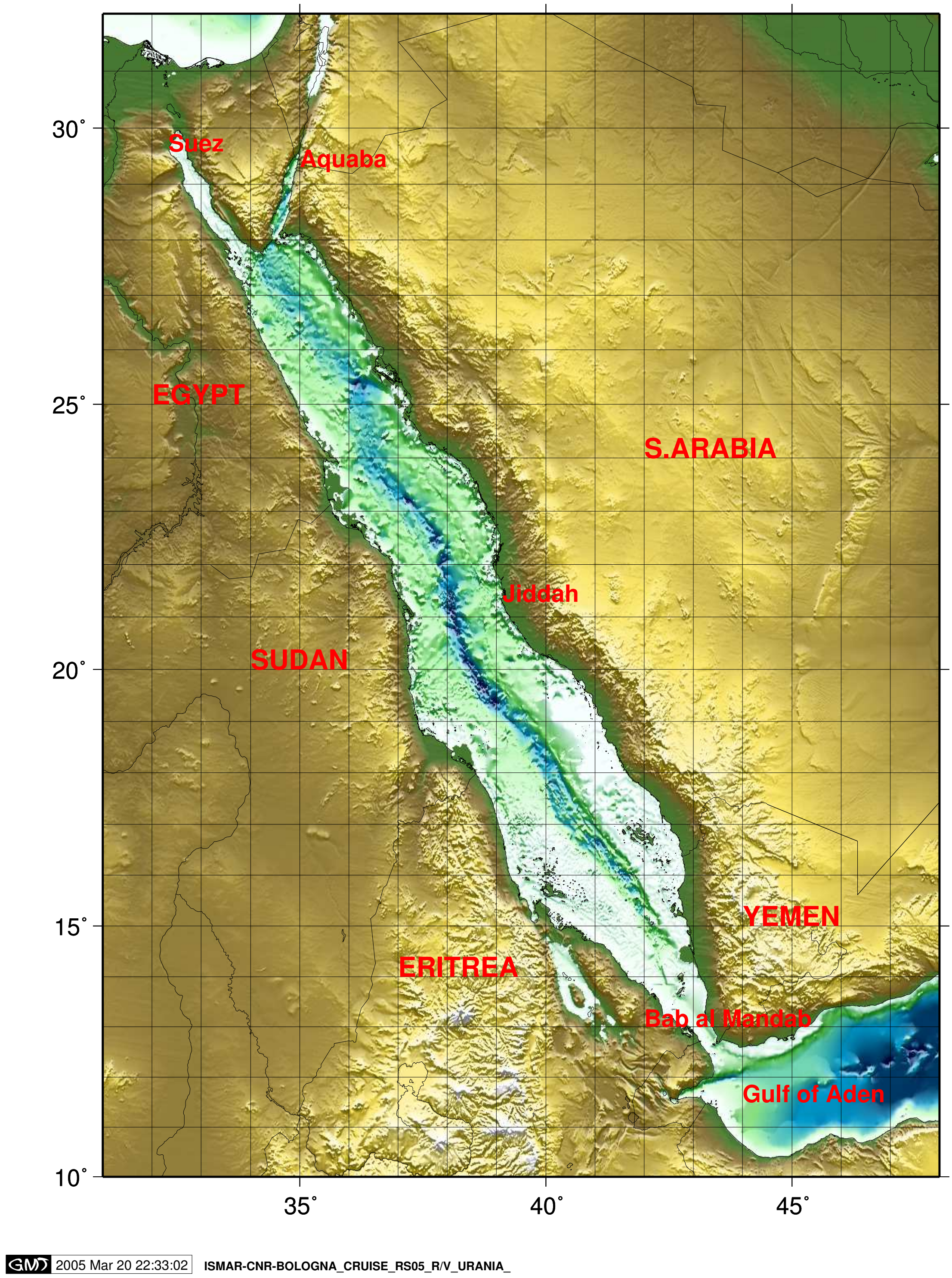

Figure 1: Geographical area setting, Red Sea. Bathymetry and topography from [GEBCO (2003)].

During the 17 days in the area, including the three days of transit, multibeam bathymetry, magnetics, oceanographic measurements, dredging, coring, surficial sediment sampling and brine water sampling were carried out. The work areas were (a) the Thetis Deep, that was intensively investigated (full coverage multibeam, magnetics, bottom rocks and brine sampling, SBP and MCS seismic), (b) the Coral Sea Peak, that was dredged and mapped, (c) the Nereus, Oceanographer and Conrad Deeps (multibeam, SBP, brine sampling). The Arabian Shelf was sampled by grab and corer. Other activities, e.g. CTD-XBT casts, ADCP and METEO measurements were performed regularly on the way or when dictated by the geophysical acquisition.

R/V Urania sailed from Naples on December 28, 2004 after a delay caused by a storm and arrived at Suez on January 5, 2005. At the end of the cruise, the ship left Port Said in the evening of January 21, 2005 for Venice, where it docked on January 27, 2005 in the evening.

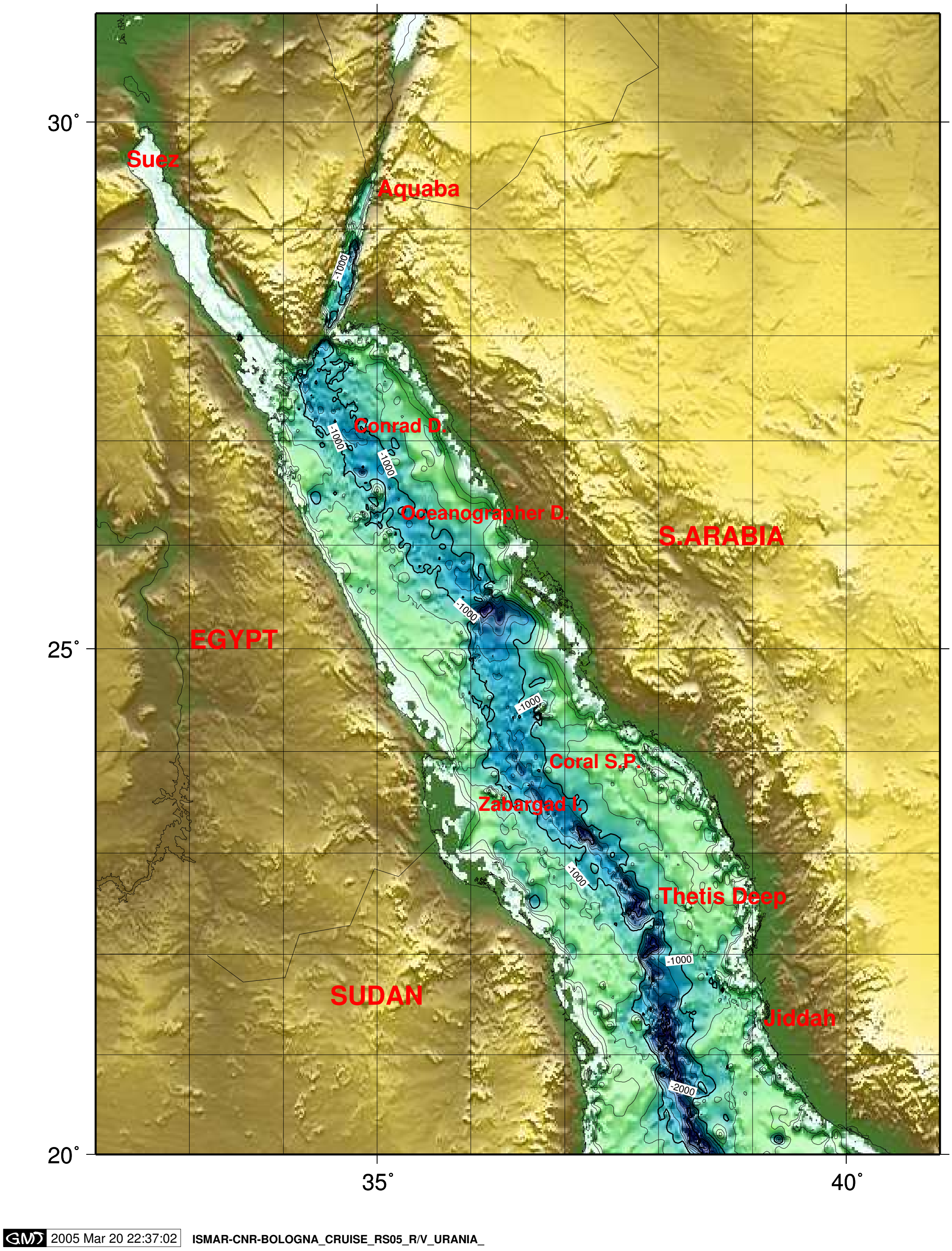

Figure 2: Geographical area setting, Northern Red Sea. Bathymetry and Topography from [GEBCO (2003)].

CRUISE PLANNING AND STRATEGY

A research cruise for 40 days in the Red Sea were initially requested but due to the demanding schedule of the research ship *R/V Urania* only 29 days of ship time was granted.

Since the study area in the Red Sea is located in the Egyptian, Saudi and Sudanese Waters it was mandatory to acquire permission to work, from the respective governments. These permissions were granted by Egypt, under the clause of having observers on board and with restriction for work inside the territorial and contiguous waters. The Saudi Arabian Government gave the permissions under an agreement with the Saudi Geological Survey. Sudanese authorities released permissions, under the clause of having two Sudanese scientists onboard.

Geophysical equipment for e.g. Multibeam Echosounder was rented from Reson, whereas multichannel systems was provided by ISMAR. Water samplers for brine sampling and analytical equipment were provided by the University of Kiel. Geological equipment, e.g. rock cutters and related gadgets were provided by ISMAR, in addition to computing devices for multibeam, seismic and general-purpose processing.

2 GEOLOGICAL AND OCEANOGRAPHICAL SETTINGS

Two research cruises were conducted by CNR (formerly Institute of Marine Geology, now ISMAR, Bologna) in 1979 (*R/V Salernum*) and 1983 (*R/V Bannock*), in the Red Sea transitional region, between 22.5N and 24.5N. These cruises gave insights into four closely spaced deeps (from south to north: Thetis, Nereus, Bannock and Vema) that seem to be younger and less evolved from south to north. From these observations, it was proposed that transition from a continental to an oceanic rift occurs in the Red Sea by initial emplacement of oceanic crust in regularly spaced cells or deeps, which serve as nuclei for axial propagation into segments of oceanic crust accretion and for initiation of seafloor spreading [Bonatti (1985)]. This segmentation could be derived either from regularly spaced diapirs of upwelling astenosphere [Bonatti (1985)], or from an initial structural segmentation of the rift in the continental stage, with transfer zones probably exploiting pre-existing structural discontinuities as observed in East African Rift [Rosendahl (1987)] and in the Gulf of Suez [Younes and McClay (2002), Khalil and McClay (2002)]. The northward propagation of the oceanization seems to end at the intersection with a major fracture zone (Zabargad Fracture Zone [Bonatti et al.(1984)], striking almost N-S and offsetting the axial valley in the Red Sea. The island of Zabargad, an uplifted block of sub-Red Sea lithosphere, lies along this important structure [Bonatti et al.(1981), Bonatti et al.(1984)]. It is hypothesized that the Zabargad Fracture Zone is a 'prototransform' that, if the Red Sea would continue its opening trend, might develop into an 'initial' major oceanic transform, similar to those offsetting today the equatorial Mid Atlantic Ridge.

The above cited 'Deeps' of the Red Sea, other than being peculiar geological structures reflecting and providing insights into the tectonic processes, present bottom water stratification with brines that are warmer, saltier, acidic and nearly saturated with respect to NaCl and highly enriched over normal RSDW composition. Moreover, they are strictly anaerobe and Fe and Mn oxides are precipitated above the chemocline of metal-rich brines [Schmidt et al.(2003)].

The salty brines are mainly formed by seawater dissolving Miocene evaporites which build up to several kilometers thick deposits under the normal pelagic/terrigeneous sediments. They are separated from normal RSDW by several meters thick interfaces, and transport across the brine-seawater interface is mainly controlled by diffusion [Anschutz and Blanc (1996), Schmidt et al.(2003)].

High gas concentrations (CO_2, hydrocarbons) were determined in the brines reaching saturation conditions in the Kebrit Deep brine [Faber (1998)]. Stable carbon and hydrogen isotope analyses of dissolved hydrocarbons in Red Sea water and brines clearly indicated a thermogenic origin of the gases due to locally high heat flows and the presence of sedimentary organic matter in the subsurface of the Red Sea deeps [Faber (1998)]. The brine/seawater interface, however, represents a zone of complex biogeochemical reactions causing highly effective methane oxidation (indicated by strong secondary isotope fractionation of residual methane having most positive $\delta\ ^{13}C$ values up to +47 % PDB; [Faber (1998)]) while methane is diffusing upwards from the brine into Red Sea bottom water. There is geochemical evidence that the biogeochemical methane oxidation process which increases brine-seawater methane fluxes most likely are combined with a reduction of Mn-oxides/ hydroxides [Schmidt et al.(2003)].

The Red Sea water is controlled by high evaporation rates, low rainfall and low runoff waters from wadis (seasonal streams), which yields to an average salinity of 40.5 PSU and temperatures ranging between 23-32°C in surface waters. Strong currents and atmospheric pressure gradients control the influx of less saline and colder water from the Gulf of Aden through the Strait of Bab al Mandeb during winter. The north-heading current mixes with a south-heading wind-driven surface current from the northern Red Sea. A thermocline at a water depth of about 200-400m separates the mixing water zone from Red Sea Deep Water at relatively stable temperature and salinity conditions. The nutrient distribution in the Red Sea is not well known and surface waters are generally depleted in nutrients [Ross (1983)]. As waters from the Gulf of Aden are also depleted in nutrients a possible scenario of nutrient supply in winter is the turbulent mixing of the above described currents and an uplift of nutrient-enriched deeper waters. The maximum turbulent mixing zone is probably in the central Red Sea.

3 CRUISE SUMMARY

SHIP: *R/V Urania*
START: 2004-12-28 PORT: NAPLES
END: 2005-01-28 PORT: VENICE
SEA/OCEAN: Red Sea
LIMITS: NORTH 28:00.0 SOUTH: 22:00.0 WEST: 33:00.0 EAST: 38:30.0
OBJECTIVE: MORPHOBATHYMETRIC, GEOPHYSICAL, GEOLOGICAL AND OCEANOGRAPHICAL INVESTIGATIONS IN THE NORTHERN RED SEA
COORDINATING BODIES: ISMAR-Bologna BOLOGNA (ITALY)
CHIEF OF EXPEDITION: Enrico Bonatti (ISMAR-CNR)
PARTY CHIEF ISMAR: Marco Ligi (ISMAR-CNR)
CONTACT: marco.ligi@ismar.cnr.it
DISCIPLINES: MORPHOBATHYMETRY, MAGNETICS,
SBP, MCS, OCEANOGRAPHY, WATER SAMPLING, SEABED SAMPLING
WORK DONE: 6500 KM^2 SURVEY + 2000 KM^2 TRANSIT MULTIBEAM,
2460 KM MAGNETICS, 2900 KM SBP, 345 KM MCS
40 XBT, 12 CTD CASTS, 4 ROSETTE SAMPLES
12 DREDGES, 5 GRABS, 1 GRAVITY CORE,
ADCP, METEO, SURFACE TEMPERATURE/SALINITY

LOCALIZATION:

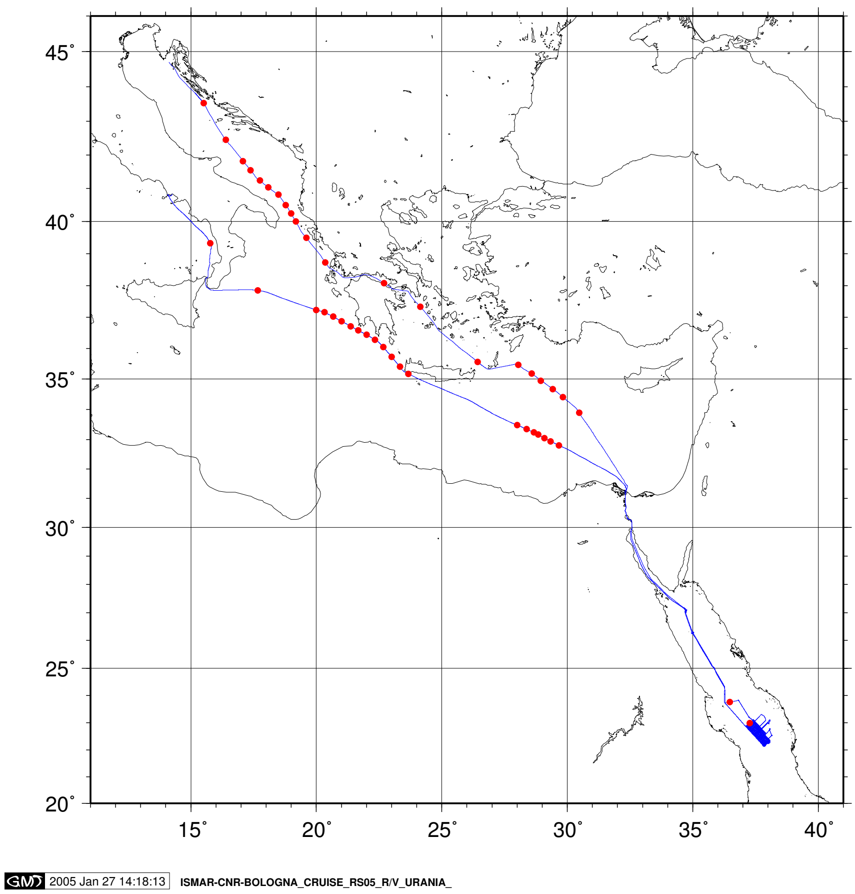

Figure 3: Ship track during Cruise RS05. The red dots are XBT stations.

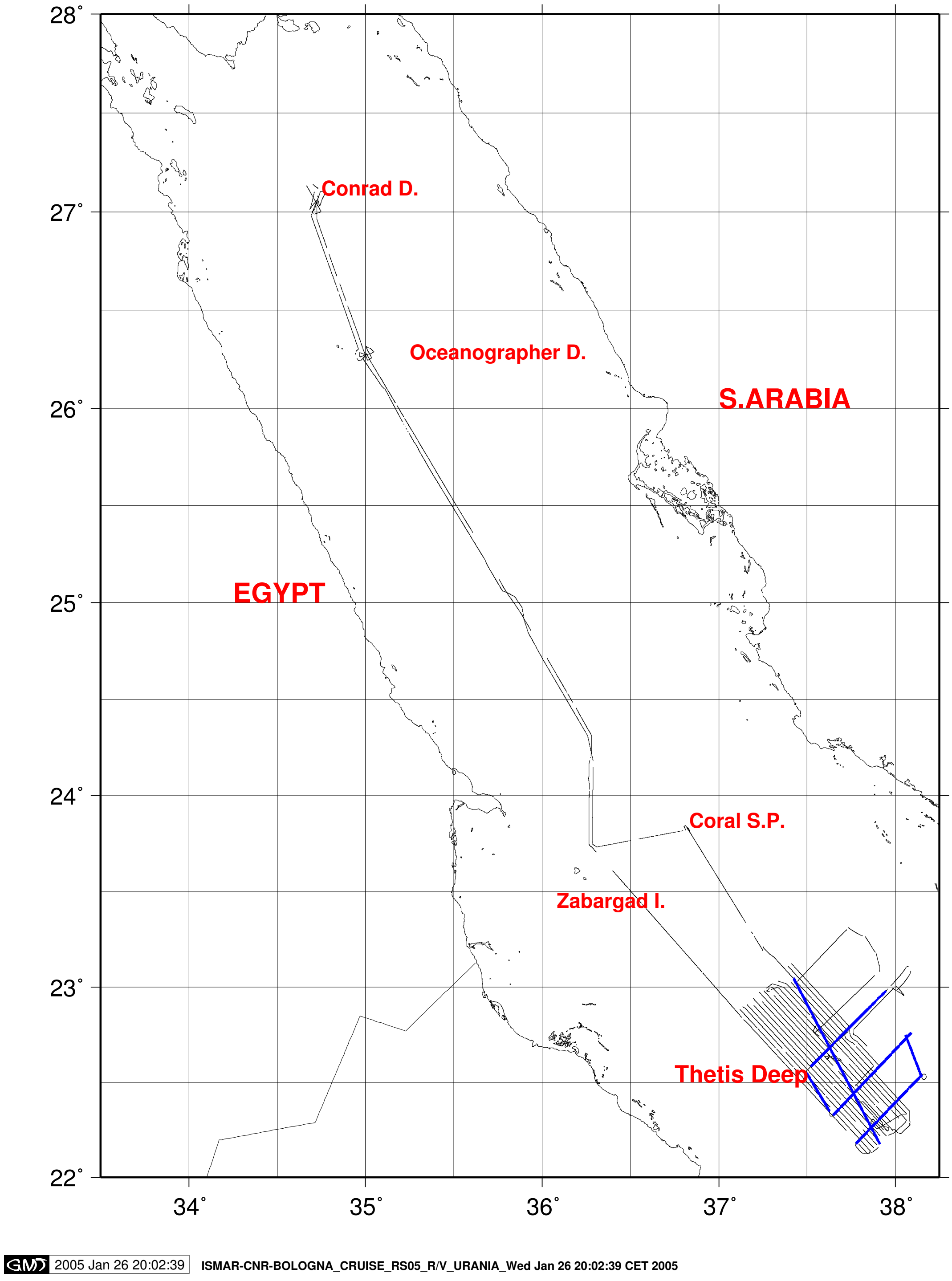

Figure 4: Ship tracks (Ship tracks, general: Multibeam, SBP, Magnetics lines (black), Multichannel lines (blue)

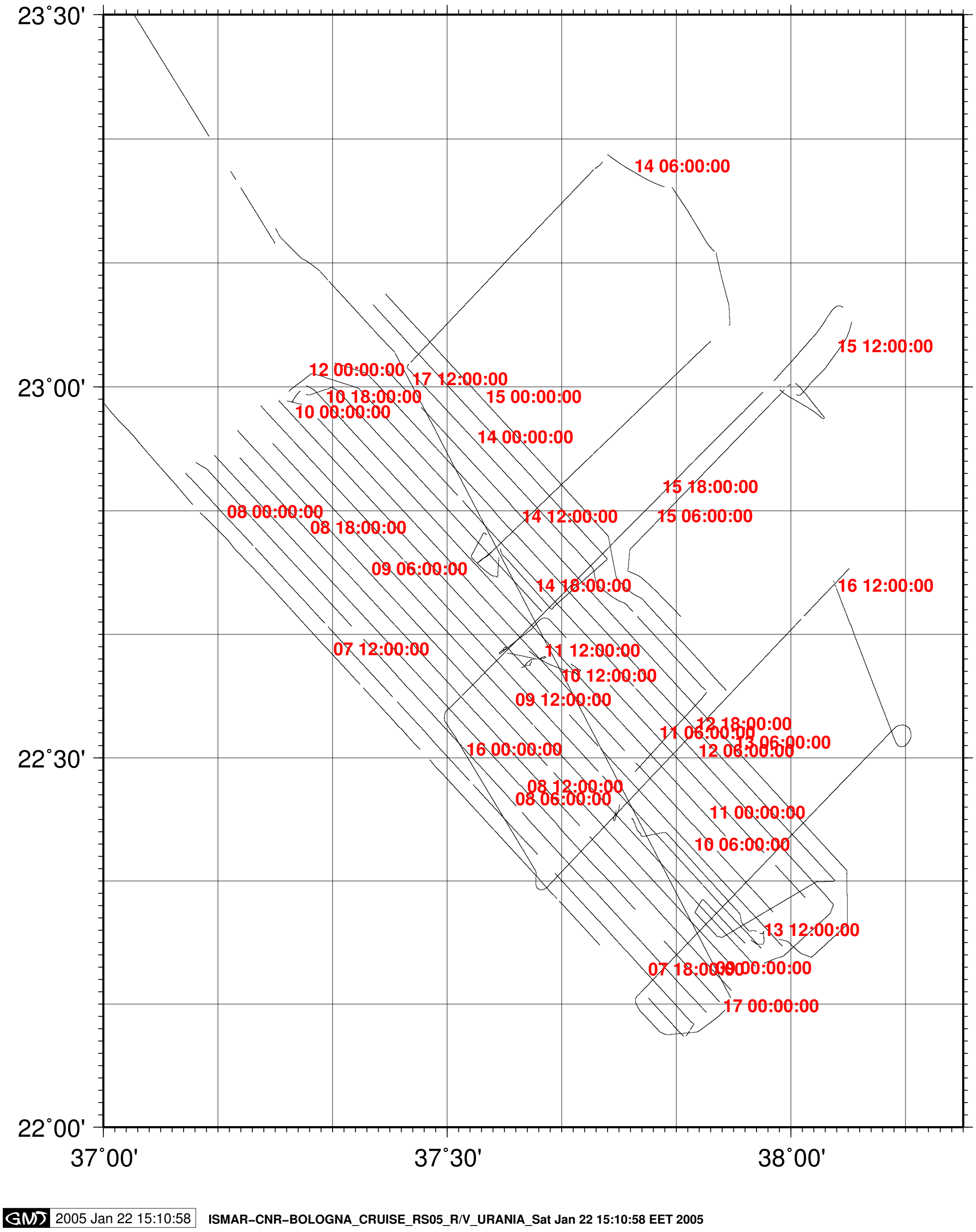

Figure 5: Ship tracks, Thetis Deep Area: Multibeam, SBP, Magnetics lines (black), Multichannel lines (blue).

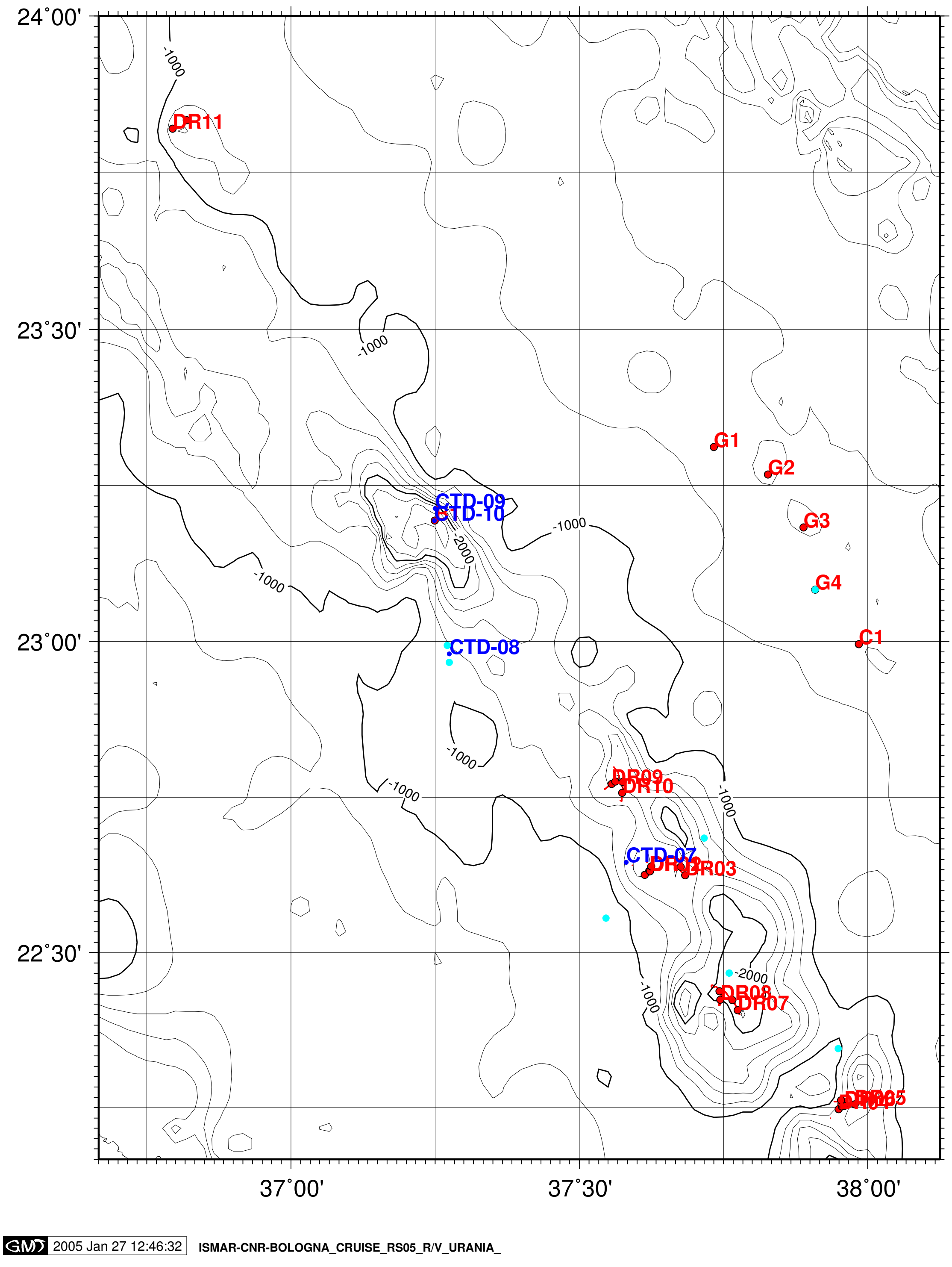

Figure 6: Samples taken in the Thetis Deep Area. DR* = dredges, GR* = grabs, CR* = cores, BR* = Brine sampling, CTD* = CTD.

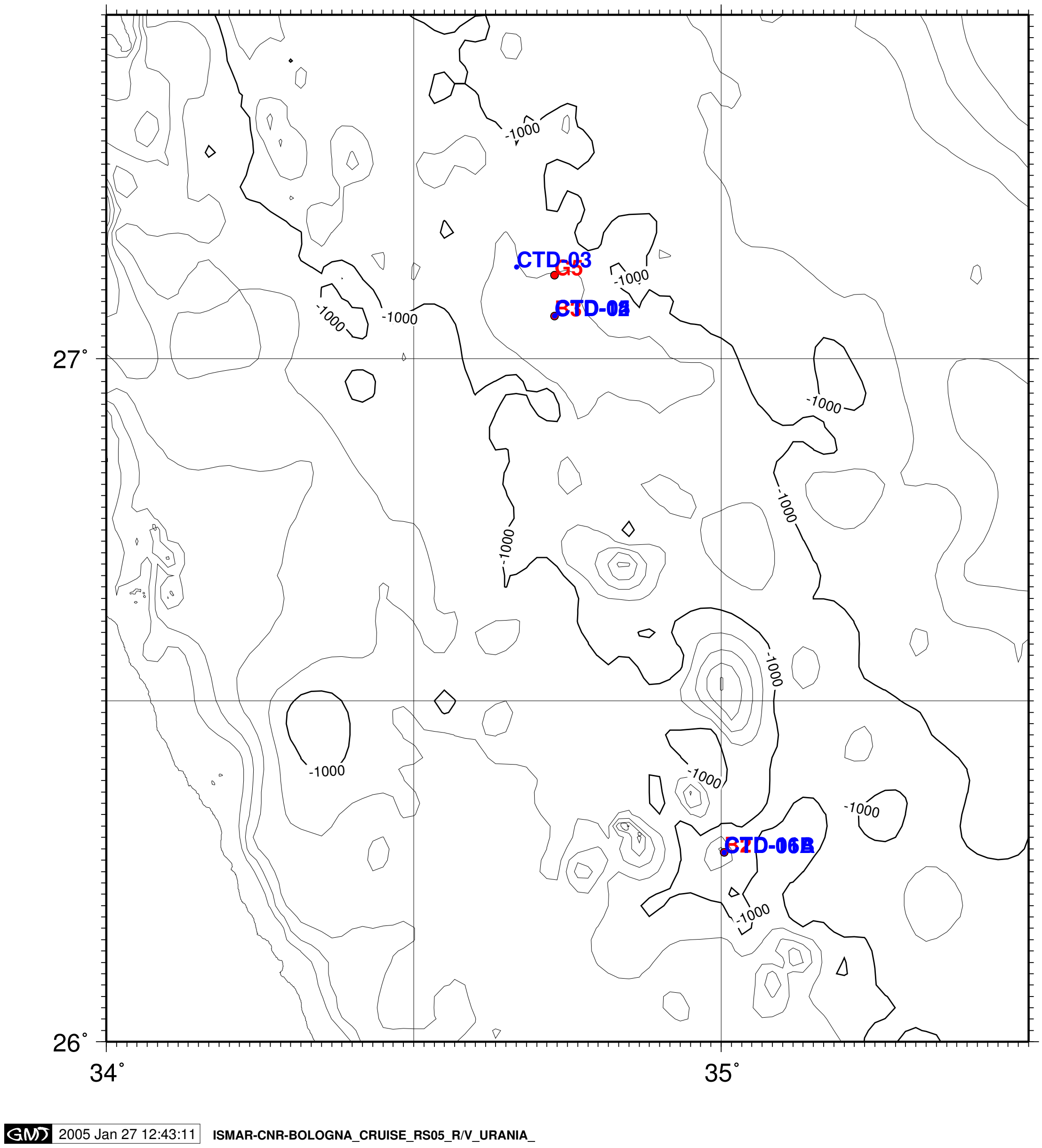

Figure 7: Samples taken in the Northern Area. DR* = dredges, GR* = grabs, CR* = cores, BR* = Brine sampling, CTD* = CTD.

SCIENTIFIC AND TECHNICAL PARTIES

PARTICIPANTS	ORGANIZATION	EXPERTISE	tel & email & www
Enrico BONATTI	ISMAR	Chief Scientist	E.Bonatti@ismar.cnr.it
Marco LIGI	ISMAR	Geophysicist	M.Ligi@ismar.cnr.it
Giovanni BORTOLUZZI	ISMAR	Technician	G.Bortoluzzi@ismar.cnr.it
Matthias LOPEZ CORREA	ISMAR	Sedimentologist	lopez@pal.uni-erlangen.de
Valentina FERRANTE	ISMAR	Geophysicist	V.Ferrante@ismar.cnr.it
Francesco REDINI	ISMAR	Structural Geologist	F.Redini@ismar.cnr.it
Antonino CALAFATO	ISMAR	Geophysicist	Calafato@geomin.unibo.it
Anna CIPRIANI	LDEO	Petrologist	anka@ldeo.columbia.edu
Giancarlo BARABINO	Univ. Roma	Petrologist	Giancarlo.Barabino@uniroma1.it
Eugenio CARMINATI	Univ. Roma	Structural Geologist	Eugenio.Carminati@uniroma1.it
Neil C. MITCHELL	Univ.Cardiff	Structural Geologist	Neil@ocean.cardiff.ac.uk
Bertrand SICHLER	IFREMER	Geophysicist	bertrand.sichler@ifremer.fr
Mark SCHMIDT	Univ.Kiel	Geochemist	mas@gpi.uni-kiel.de
Manfred SCHMITT	GCA	Geochemist	gca-labor-ms@t-online.de
Najeeb M. RASUL	SGS	Marine Geologist	Rasul.NM@sgs.org.sa
Salem Mohsen AL-NOMANI	SGS	Marine Science	Nomani.SMI@sgs.org.sa
Fares BAHARETH	SGS	Marine Science	Bahareth.FZ@sgs.org.sa
Samir M. KHALIL	Univ.Suez	Structural Geologist	S_Khalil3@yahoo.co.uk
Radwan K. FARAWATI	Univ.Jeddah	Oceanographer	RFarawati@kaau.edu.sa
Daniele GITTO	GEI	Technician	dgitto@tiscali.it www.geitaliana.com
Mario RASPAGLIOSI	SOPROMAR	Technician	m.raspagliosi@katamail.it
Ahmed SHAWKY	Egyptian Navy	Observer	mrviga13@yahoo.com
Yahya M. AL-HAZMI	S.Arabian Navy	Observer	Y.M.Alhazmi@hotmail.com

Table 2: Scientific and technical parties

Figure 8: *R/V Urania* .

4 MATERIALS AND METHODS

The research cruise was carried out by the 61 meter *R/V Urania* (Fig.8), owned and operated by SO.PRO.MAR. and on long-term lease to CNR.

The boat is normally used for geological, geophysical and oceanographical work in the Mediterranean Sea and adjoining waters, including but not limited to, the Atlantic Ocean, the Red Sea, and the Black Sea.

R/V Urania is equipped with DGPS positioning system, single-beam bathymetry and integrated geophysical and oceanographical data acquisition systems, including ADCP, CHIRP SBP and other Sonar Equipment. Additional equipment such as MBES systems can be accommodated on the keel by sub work.

The survey was planned to carry out the following tasks

- MBES with a high resolution multibeam, capable of investigating the sea bottom down to depths between 2300 and 2500 m,
- SV measurements either by CTD probe or XBTs,
- Magnetic investigations,
- SBP investigation
- Multichannel reflection Seismic
- Water and brine sampling from the Deeps
- Dredging and sediment sampling (core and grab)

In addition to these main operational activities, routine on-the-way measurements (ADCP, meteo, surface C/T, etc) were acquired.

The areas to investigate were :

A the Conrad Deep

B the Oceanographer Deep

C the Thetis Deep

D the Coral Sea Peak

4.1 NAVIGATION AND DATA ACQUISITION

The vessel was set-up for data acquisition and navigation with RESON PDS-2000 and COMM-TECH NAVPRO softwares. Two workstations were used for

- multibeam, interfacing by a multiserial and Ethernet link a RESON 8160 P1 processor, an Octans MRU and gyrocompass, DGPS receiver;
- magnetics, meteorological station, conductivity/temperature sensors at the keel,DESO echosounders, dredging cable tension and the DGPS receiver.

The latter workstation also collected the navigational data every minute and at different sampling rates.

The Positioning system NAVPRO V5.6 provided by Communication Technology (Cesena, Italy) was used. The integrated system used a Microtecnica Gyrocompass, and a Trimble 4000 Differential Locator, with a DGPS Satellite link by FUGRO. Instruments were interfaced by a Digiboard Multi Serial I/O.

The datum WGS84 and the UTM projection on 39E (zone 37) were chosen for navigation and display purposes. Timing was set to UTC whereas the acquisition rate was set to 10 secs. The SBP-CHIRP workstation received the 'VESSEL(0,0)' positions by the NAVPRO serial output. The positions were therefore recorded on the SEGY trace headers. The speed of sound for echosouder ATLAS-KRUPP DESO 25 (33Khz) was set at 1535m/sec, with a transducer immersion of 3.8m.

The NAVPRO computer also interfaced an ANDERAA metereological station and a conductivity/temperature sensor at the keel (depth of 3.5m), and the data were collected at the same rate as above.

The navigation system PDS-2000 V2.3.4.35 by RESON was used for Multibeam data acquisition. The system interfaced the RESON 8160 Operator's console, an OCTANS gyrocompass and MRU, and the Trimble 4000 DGPS receiver.

The RESON 8160 MBES sonar head was positioned by sub on the ship's keel using a V-shaped steel frame, and the cable's dry end passed trough a pipe after water-proofness. The sound velocity probe at the Sonar Head went out of service immediately after departure from Naples. We therefore were bound to use the Conductivity/Temperature data at the keel provided by the ANDERAA Metereological Data Logger. The data obtained were converted to speed of sound and input manually into the Multibeam Console.

An RDI ADCP @300Khz was in operation throughout the research cruise in the Red Sea. The positioning and attitude data were provided by a 4 antenna Ashtec GPS.

A Geometrics G811 Magnetometer tow fish was towed 200m astern, on the port side.

A seismic source Array was towed 25 m astern, and the first active section of the 48 Ch. seismic streamer was towed 150 m astern.

The instrumental offsets are presented in Fig. 9 and in Tab. 3.

POSITION	ALONG	ACROSS	HEIGHT
ANTENNA (POS 1)	5.70	1.40	15.0
VESSEL (POS 2)	0	0	0
MBEAM	3.00	0.0	-5.00
OCTANS	3.35	0.0	-3.40
ECHO SOUNDER 33	5.50	-1.85	-3.80
CHIRP	-5.50	-0.95	-3.80
CORER	-15.10	7.0	
STERN	-47.5	-1.40	
GI-GUN ARRAY	-65.0	5.0	
FIRST ACTIVE 48CH	-190.0	0.0	
MAG	-220.0	-3.90	

Table 3: Instrumental Offsets on Ship Urania. Point (VESSEL(0,0)) is located on the axis of the mast just behind the Command Bridge. The main GPS antenna (primary positioning system) is located on point POS1.

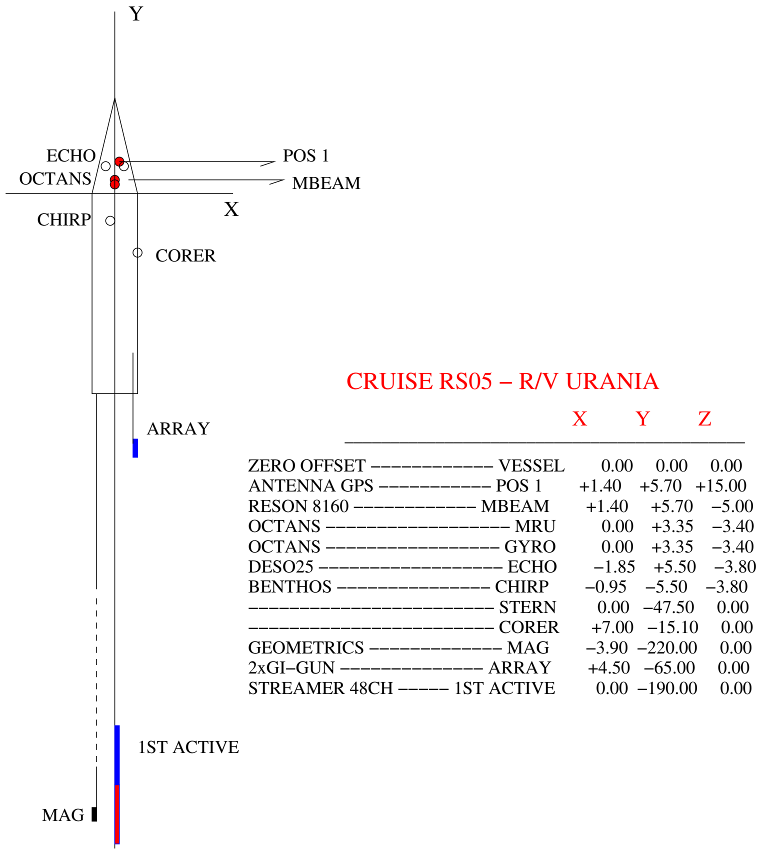

Figure 9: Cruise RS05. Instrumental Offsets on *R/V Urania*

4.2 CTD, WATER SAMPLING AND SOUND VELOCITY DATA

CTD casts were taken for sound velocity from different sites and from brine and water sampling stations.

The sound velocity profiles were calculated from CTD data obtained data by an SBE Mod.19Plus and ME probes, and by XBT launches data collected by a Sippican Mod. MK21 profiler.

In addition, conductivity/temperature data at the keel were measured continuously on-the-way, while the speed of sound was calculated by the UNESCO/WHOI routine procedures and logged into the Multibeam 8160 RESON console. The data was cross-checked against the Sea Bird probe, for compatibility and accuracy.

The position of the CTD and XBT stations are shown in Fig. 6 and 7, and are reported in Table 4 and 5.

The Sound Velocity profiles were used for real-time acquisition and post-processing.

4.2.1 WATER SAMPLING

Water and brine sampling was performed with a Hydrobios-rosette equipped with 12x10 L Niskin bottles and a CTD (SeaSunTechnology, Trappenkamp)(Fig.10). The CTD records temperature, sound velocity, transmission, and water depth (pressure given in dbar). Based on past experience, contamination of water samples was avoided by slowly approaching the brine from the top and sampling the upper part of brine-seawater interface before sampling the lower part. The sampling interval was 1-2 m (Tab.4) using Niskin bottles and a relative error of 0.5 m was estimated by pressure change during release of the bottles.

Station	Area	Longitude	Latitude	Btl	Depth	Depth	Temp	Depth	Remarks
		(E)	(N)		(db)	RL(m)	(C)	Max(m)	
CTD-4	Conrad	34 43.764'	27 03.743'						Profile
CTD-5	Conrad	34 43.764'	27 03.743'	1	25	25	23.7	1500	Profile
CTD-6a	Oceanographer	35 00.306'	26 16.65'	1		200		1475	P/S NUT/TRE
				2		150			
				3	97.5	100	22.09		
				4	72.5	75	22.59		
				5	48.3	50	22.9		
				6	23.5	25	23.75		
				7	9.5	10	23.35		
				8	5	5			
CTD-6b	Oceanographer	35 00.310'	26 16.661'	9	999	1000	21.63	1535	P/S NUT/TRE
				10	1347	1350	21.7		
				11	1364	1365	21.73		
				12	1388	1390	21.77		
CTD-7	Thetis-I	37 34.862'	22 38.730'	1	1967	1965	21.8	1965	P/S NUT/TRE/GAS
				2	994	1000	21.59		
				3	697	700	21.56		
				4	496	500	21.55		
				5	245	250	21.74		
				6	193.5	200	22		
				7	124.5	130	23.03		
				8	95	100	25.2		
				9	86	90	25.6		
				10	46	50	25.25		
				11	21	25	25.24		
				12	6.2	10	25.23		
CTD-8	Thetis-II	37 16.30'	22 58.51'					1185	P
CTD-9	Nereus Deep	37 15.00'	23 12.82'	1	494	500	21.58		P/S NUT/TRE/GAS
				2	244	250	22.17		
				3	195	200	23.19		
				4	144	150	24.13		
				5	95	100	24.24		
				6	84	90	24.23		
				7	45	50	24.22		
				8	20	25	24.31		
				9	5	10	24.72		
CTD-10	Nereus Deep	37 14.93'	23 11.63'	1	2440	2423	22.59	2460	P/B TRE/GAS
				2	2440	2423	22.59		
				3	2443	2426	22.9		
				4	2445	2429	24.1		
				5	2452	2432	26.1		
				6	2463	2442	30.25		
				7	2471	2453	29.96		
				8	2471	2453	29.96		
				9	2469	2451	29.23		
				11	2410	2392	21.92		
				12	1007	1000	21.6		
CTD-11	Oceanographer	35 00.259'	26 16.724'	1	1429	1420	21.86	1560	P/B TRE/GAS
				2	1434	1425	21.91		
				3	1437	1428	21.94		
				4	1444	1435	22.71		
				5	1448	1438	23.74		
				6	1450	1440	24.2		
				7	1474	1460	24.86		
				8	1497	1480	24.88		
				9	1520	1500	24.88		
				10	1544	1520	24.89		
				11	1555	1530	24.9		
				12	1570	1555	26.46		
CTD-12	Conrad Deep	34 43.790'	27 03.757'	1	1000	1000	21.62	1505	P/B TRE/GAS
				2	1478	1475	21.7		
				3	1480	1477	21.7		
				4	1486	1483	21.89		
				5	1488	1485	22.66		
				6	1493	1488	22.96		
				7	1494	1490	22.97		
				8	1506	1500	23.02		
				9	1506	1500	23.02		
				10	1500	1495	22.97		
				11	1484	1480	21.7		
				12	18	20	22.55		

Table 4: RS05 CTD Stations location and description. P=Profile, S or B Water or Brine Sampling. TRE=Trace elements, NUT=Nutrient, GAS=Gas analyses.

LON	LAT	DATE	TIME	TYPE	S/N
15:46.400E	39:19.599N	2004-12-29	15:29:51	T-7	00928922
17:40.335E	37:51.095N	2004-12-30	09:46:31	Fast-Deep	00004327
19:59.730E	37:14.230N	2004-12-30	21:25:05	Deep-Blue	00946560
20:19.861E	37:09.566N	2004-12-30	23:07:51	Deep-Blue	00946559
20:40.373E	37:01.333N	2004-12-31	01:02:06	Deep-Blue	00946628
21:00.668E	36:52.230N	2004-12-31	03:09:25	Deep-Blue	00946627
21:21.918E	36:43.019N	2004-12-31	05:20:39	Deep-Blue	00946629
21:40.334E	36:34.680N	2004-12-31	07:08:04	Deep-Blue	00946630
22:00.273E	36:26.345N	2004-12-31	08:54:45	T-5	00313541
22:20.276E	36:16.849N	2004-12-31	10:42:23	T-5	00313542
22:39.802E	36:02.874N	2004-12-31	12:43:37	T-5	00313537
22:59.979E	35:43.767N	2004-12-31	15:04:47	Deep-Blue	00947113
23:20.163E	35:24.268N	2004-12-31	17:20:58	Deep-Blue	00947114
23:40.350E	35:10.433N	2004-12-31	19:21:50	Deep-Blue	00947115
28:00.538E	33:28.614N	2005-01-01	17:25:21	T-5	00313543
28:22.678E	33:20.556N	2005-01-01	19:10:42	Deep-Blue	00947119
28:40.208E	33:13.937N	2005-01-01	20:26:33	Deep-Blue	00947118
28:50.392E	33:09.614N	2005-01-01	21:15:00	Deep-Blue	00947123
29:05.118E	33:02.725N	2005-01-01	22:31:02	Deep-Blue	00946756
29:20.100E	32:56.200N	2005-01-01	23:51:38	Deep-Blue	00947122
29:40.420E	32:47.894N	2005-01-02	01:41:53	Deep-Blue	00947117
36:15.867E	23:46.370N	2005-01-06	22:36:14	Deep-Blue	00947121
36:10.563E	23:47.902N	2005-01-07	09:16:27	Deep-Blue	00000000
37:50.550E	22:07.460N	2005-01-07	16:06:14	Deep-Blue	00946634
37:32.785E	22:33.345N	2005-01-08	19:32:06	Deep-Blue	09946642
37:16.243E	22:59.628N	2005-01-10	16:26:05	Deep-Blue	00946760
37:16.243E	22:59.628N	2005-01-10	16:26:05	Deep-Blue	00946760
37:16.486E	22:58.000N	2005-01-11	21:39:16	Fast-Deep	00004326
37:42.990E	22:41.040N	2005-01-12	18:38:02	Deep-Blue	00946643
37:45.590E	22:28.030N	2005-01-13	17:59:46	T-5	00313536
37:54.550E	23:04.980N	2005-01-14	07:54:57	T-7	01029278
37:56.940E	22:20.730N	2005-01-16	18:08:59	T-7	01029274
36:29.010E	23:45.740N	2005-01-18	03:58:15	Deep-Blue	00946635
30:28.402E	33:53.222N	2005-01-22	16:10:40	T-5	00313534
29:49.800E	34:24.330N	2005-01-22	21:09:04	Deep-Blue	00946755
29:25.453E	34:40.598N	2005-01-23	00:03:36	Deep-Blue	00946636
28:57.000E	34:57.000N	2005-01-23	03:28:13	Deep-Blue	00946754
28:34.848E	35:10.686N	2005-01-23	05:54:17	T-5	00313535
28:02.708E	35:27.790N	2005-01-23	10:14:55	Deep-Blue	00946640
26:25.452E	35:33.976N	2005-01-23	21:34:27	T-7	01029280
24:08.736E	37:20.227N	2005-01-24	13:36:59	T-4	00320203
22:42.227E	38:04.779N	2005-01-24	23:29:33	T-7	01029281
20:21.568E	38:43.975N	2005-01-25	12:29:44	Fast-Deep	00004331
19:35.902E	39:29.953N	2005-01-25	17:56:59	Deep-Blue	00946639
19:10.621E	40:00.241N	2005-01-25	21:22:49	Deep-Blue	00946638
18:59.841E	40:14.656N	2005-01-25	23:00:03	T-7	01029276
18:46.978E	40:30.038N	2005-01-26	00:46:03	T-7	01029237
18:29.521E	40:48.830N	2005-01-26	03:07:25	T-7	01029275
18:04.756E	41:02.411N	2005-01-26	05:38:32	T-7	01029271
17:45.130E	41:15.000N	2005-01-26	07:42:48	T-7	01029277
17:22.950E	41:32.941N	2005-01-26	10:08:51	T-7	01029272
17:04.750E	41:49.521N	2005-01-26	12:11:59	T-7	01029273
16:23.834E	42:27.431N	2005-01-26	17:04:39	T-4	00320198
15:30.885E	43:31.436N	2005-01-27	00:49:52	T-4	00320202

Table 5: Cruise RS05: XBT launches data.

Hydrocarbon gas concentrations and isotope measurements

Water and brine samples were taken for CH_4 concentration measurements. Immediately after the water rosette was on deck the water was transferred into 1 liter glass bottles which subsequently were degassed onboard using an ultrasonic vacuum system [Schmitt et al.(1991)], Fig.11. The dissolved gas is stored in gas-tight 25 ml glass vials for land-based analyses of hydrocarbon concentrations using a gas chromatographic system followed by mass spectrometric analyses of stable carbon and hydrogen isotope compositions [Faber (1998)]. The results will be used to quantitatively describe CH_4 exchange across the brine seawater interface and recognize hydrocarbon oxidation processes. A parallel brine sample of selected depths was degassed and the gas was stored to measure the ^{14}C activity of methane at the Leibniz Institute for Age Dating, Kiel.

Figure 10: Hydrobios Rosette sampler.

Dissolved inorganic carbon and oxygen isotope compositions of brines and seawater

Immediately after recovery of the Niskin bottles water was sampled in 100 ml sample vessels. 0.2 ml of mercury chloride solution was added to each sample in order to prevent further bacterial activity. The samples were then sealed and stored for later land-based analyses. Carbon and oxygen isotope analyses of water and DIC will be performed at the Leibniz Institute for Age Dating in Kiel (H. Erlenkeuser).

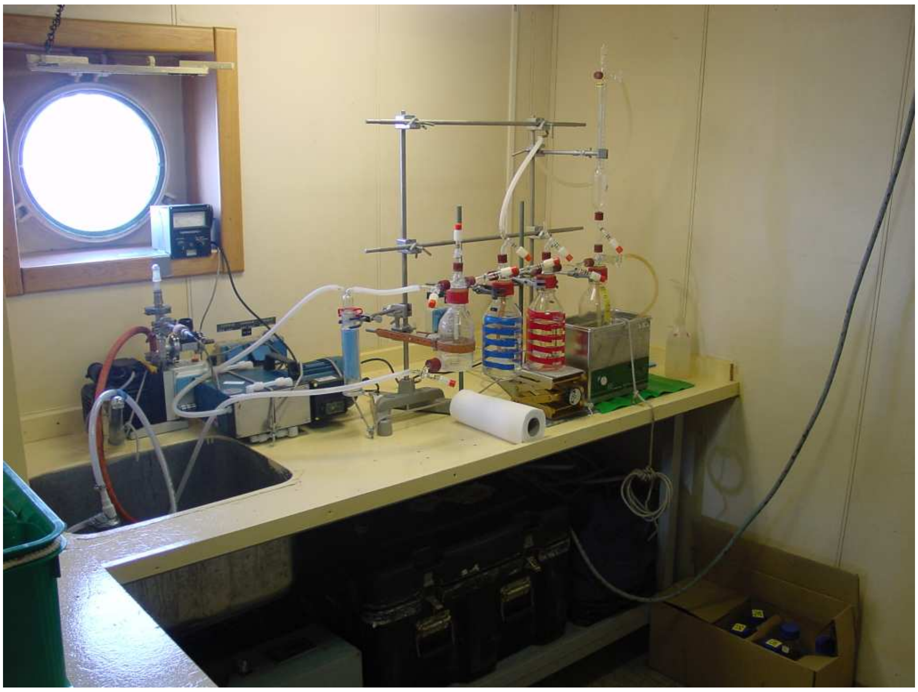

Figure 11: Degassing system.

Inorganic trace elements and nutrients

Water and brine samples were filled into 60 ml FEP teflon bottles, pre-washed with HNO_3 and were stored at -20° C for further analyses (bulk composition and anions) at the Institute of Geosciences, Kiel. Any contact of the water sample with ambient air was avoided. 500 ml of brine samples were filtered immediately after sampling (Sartorius filtration device) by using water jet pumps. The samples were filtrated through a 0.2 μ m polycarbonate membrane filter (Nuclepore). The remaining filtrate (125 ml) will be used for the determination of dissolved major (Na, K, Ca, Mg, Si) and trace elemental composition (Li, Rb, Cs, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Sr, Y, Mo, Ag, Cd, In, Sn, Sb, Ba, REE, W, Tl, Pb, Bi, TH, and U) by ETAAS, ICPAES, ICPMS. After filtration of the brine membrane filters were recovered and stored in pre-cleaned polycarbonate petri-dishes for the determination of particulate elemental composition. A second set of water samples for nutrient and trace metal analyses was collected in 500 ml acid cleaned HDPE-bottles (cleaned with 1M HCl acid) and stored at -20°C after collection. These samples will be analyzed at the laboratories of Marine Chemistry Department at King Abdulaziz University, Saudi Arabia. Nutrients will be analyzed using spectrophotometric methods whereas trace metals will be analyzed using cathodic stripping voltammetry.

4.2.2 CONTINUOUS SURFACE C/T PROFILING

The ship continuously measured the Conductivity and Temperature of the sea water at the keel level (3.50m) by pumping it to the recording room to ANDERAA sensors and recorded on the NAVPRO navigation software at the selected sampling rate (minimum 1 sample/minute). The conductivity data were transformed to salinity by the WHOI/UNESCO Oceanographical routines. A rough control with some CTD data evidenced offsets, that were summed to the values used for the calculation of the speed of sound at the Multibeam Sonar (0.6 PSU).

A better analysis was done later during the survey, taking into account previous cruise data (MEDGOOS9, Oct. 2004, 60 CTD stations). A marked offset was evidenced for the Conductivity value, whilst the Temperature values fitted well on the curve. The regression statistics led to the equation Ca = 0.9244 Cc + 3.1056, where Ca is the value read from the ANDERAA, and Cc is the reference.

4.3 MULTIBEAM BATHYMETRY

The MBES was the 50 Khz, 126 1.5° beams, 150°aperture RESON 8160, capable to acquire data at a range of 3000 m depth. The sonar data were collected and recorded in realtime on HD by direct interfacing of the sonar processor P1 to the PDS-2000 software. In addition two data sets were generated and stored on separate computer for backup on HD and CD/DVD. The PDS-2000 was able to build a 25 m DTM during the acquisition of the entire surveyed area.

CALIBRATION

The MBES was calibrated in the Thyrrhenian Sea during the previous cruise. The data is presented in Tab.6. Several lines were acquired during the survey, that will be used as further calibration control.

8160	RS05
roll offset	0.5 °
pitch offset	2.0 °
heading offset	-2.0 °
time delay	0.0 s

Table 6: RESON 8160 Multibeam calibration results.

4.4 MAGNETOMETRY

The Geometrics Mod. G-811 was used. The towfish was kept 180 m off the stern. The data was collected by the NAVPRO workstation on NS lines 2.0-2.5 km apart, including some diagonal lines, as dictated by multibeam coverage and multichannel seismic line patterns.

The following data processing steps were applied:

- extraction of the navigation and total field ASCII data from the NAVPRO data files
- polar transport (220 m distance, angle (hdg-180)) to get the towfish position
- application of the IGRF 2005 to every point
- production of grids in geographical/metric coordinates for QC and analysis (step 0.75 nm/0.5 nm and 100 m)

4.5 CHIRP SBP

SBP data was acquired by the 16 transducers, hull mounted BENTHOS (DATASONICS) Mod.CAP-6600 CHIRP-II profiler, with operating frequencies ranging between 2 and 7 Khz. The pulse length was mantained at 20 ms while the trigger rates varied from 0.5 to 4 seconds according to water depth. The signal penetration was up to 45 m below the sea floor. Some analog sections were printed in real time on a 22" EPC recorder. Digital data were recorded in the SEG-Y format on Magneto-Optical removable disks and hard disk. Backups were loaded on DAT tapes, DVD and CD-ROM. The navigation data was made available to the system by NAVPRO as VESSEL (0,0) at a rate of aproximately 0.5 hz. The position data were recovered from routines developed at ISMAR (`read_segy`) that read the SEGY header to check data integrity and retrieve positioning and recording data. The latter were for producing the navigation map. SEG-Y header and trace data were also checked with the ISMAR's software SEISPRO [Gasperini and Stanghellini(2005)].

4.6 SEABED SAMPLING

The sea bottom samples were taken by cylindrical dredges, Van-Veen grab and 1.2 Ton gravity corer (Fig.12).

Rocks and sediments collected by dredging were described on board, logged, sub-sampled and stored away as archive and working samples. Some rocks were cut and polished for further analyses (thin-sections, microscopic observations, etc.). The sediment from the five grab sampling stations were described, logged, sub-sampled for bulk mineralogy, bulk biology, clay mineralogy, petrographic analysis and sedimentology. Sediment colour, based on the Munsell Rock Chart was predominantly 7.5 YR 7/3 Pink and occasionally 10 YR 6/1 Gray. The PVC-liner of the gravity core was subsequently cut into 1 meter sections and labelled. The core liners will be split for detalied analysis at the shore-based laboratories. Detailed sedimentological and geochemical studies will be carried-out at the Saudi Geological Survey, Saudi Arabia and at the Istituto Di Scienze Marina, Bologna, Italy.

The sample locations are shown in Figg.6 and 7.

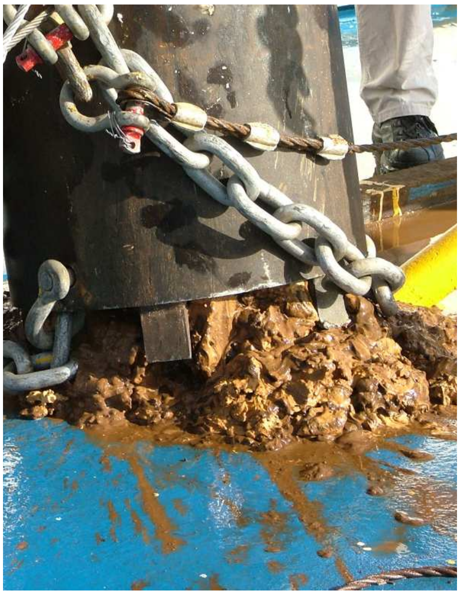

Figure 12: Dredge.

4.7 MULTICHANNEL SEISMIC

High resolution multichannel seismic were performed using an array of two synchronized SERCEL (formerly SODERA-SSI) GI-GUN (Fig.13), (in the 105+105 c.i. Harmonic configuration) pneumatic sources, powered by a 2500 L/Min, electrically driven, Mod. I28 air compressor by BAUER. The pressure to the gun was set to 140 Bar (2500 psi), actually ranging between 125 and 145 Bars. The seismic data were collected by a MOD.29500 TELEDYNE 48 channel streamer (Fig.15), digitized and recorded on DDS-1 and DDS-2 DAT tapes by a OYO-GEOMETRICS's STRATAVISOR seismograph in the SEG-D 8048 Revision.0 format, with sampling rate of 1 msec and record lenghts of 12 secs. The group interval was 12.5m for a total active length of 600 m. The 150 m tow leader and two 50 m stretch sections made up the streamer to a total length of 850 m. The seismic source was fired by IGM's gun-control equipment [Masini and Ligi (1995)] (14), that introduced a fixed delay of 10 msec from the time break, where the injector delay floated around 44.5 msec. Shot distances were of 50 m, thus achieving coverages of 600%. The time break was provided by the seismic module in the NAVPRO software, with the *DISTANCE FROM PREVIOUS SHOT* setting, in order to maximize the survey flexibility allowing the *SHOT NOW* capability when enroute. The depth of the source ranged between 5 and 6 m. The streamer was kept at 10-12 m depth with SYNTRON RCL-2 cable-levelers, using a Teledyne Mod. 28951 depth control system.

The data were processed onboard using the DISCO/FOCUS packages by PARADIGM, up to the time-migration of some sections, using a standard processing sequence.

Figure 13: GI-GUN Array.

Figure 14: GI-GUN Array Synchronizer.

Figure 15: Multichannel streamer.

4.8 MISCELLANEOUS

The datum was set to WGS84 and the UTM projection (zone 37) was chosen for navigation and display, and data acquisition. The time zone was set to the local time (UTC+2) for the whole data acquisition process, except for the SBP data that was recorded in UTC.

The positioning maps and bathymetric images were done with GMT [Wessel and Smith (1995)]. The multibeam data were pre processed on board by the PDS-2000, CARAIBES, NEPTUNE and MB-SYSTEM softwares.

Bathymetric data were complimented by the GEBCO data. On-land SRTM topography data was used for structural analysis, after conversion to NETCDF GMT grid files.

The computing center used three INTEL based PC running the SUSE GNU-Linux and the Microsoft Windows 2000 O.S., and two SUN workstations running Solaris 8, in addition to some portable computer for data acquisition and efficient data processing.

Photographs were taken by digital cameras.

The Linux machines were used as data repositories using the SAMBA software. A WWW server on a Linux machine was used to share ongoing information and results.

5 INITIAL RESULTS

Initial results are presented, in order to address the importance of the preliminary findings and processing sequence of the data acquired. As explained in Chapter 4, during the cruise we acquired:

- multibeam bathymetric data
- CTD and SVP casts ranging from 0 to 1800 m water depth.
- magnetometric data
- MCS
- SBP
- Current meter data
- water samples
- bottom samples (dredges, grabs, cores)

5.1 BATHYMETRY

Pattern of the multibeam lines during the 12 days of operation in the study area are presented in Fig.4. A surface of approximately 8500 Km^2 was covered in the Thetis, Conrad, Oceanographer Deeps and Coral Sea Peak areas. A partial processing of the acquired data by the RESON 8160 was carried-out during the cruise with the Caraibes and Neptune softwares. The quality of the data acquired varied from very good to acceptable, excluding a few lines obtained in bad weather conditions because of the rough seas. A detailed survey was carried-out in the Thetis Deep area extending the survey to the south in the transition zone to the Hadarba Deep and to north in the transition zone to the Nereus Deep, where the eastern margin was also mapped during the water sampling operations and transit to the Coral Seapeak.

The DTM and maps were produced by (a) filtering the UTM-37 25m PDS-2000 DTM data with a batch ISMAR procedure (`filter_bat`) to eliminate spikes and high-frequency noise, (b) creating NETCDF grids with the GMT `nearneighbor` or `surface` algorithms or straight to with `xyz2grd`, (c) gaussian filtering, when required, and (d) plotting the maps in the UTM and geographical domains (GMT routines complemented by ISMAR routines).

The bathymetry of the Thetis deep shows three asymmetric ”subdeeps” which are smaller and shallower from north to south. The ”subdeeps” are separated by transition zones and are characterised by several volcanoes and evaporite-mobilization structures. The structural architecture of the deep is generally formed by a series of fault segments with dominant NW orientation, subparallel to the rift axis. These are linked by relay ramps, some of which are breached by local transfer faults.

The Conrad Deep (Fig.16) shows an elongate shape, oriented parallel to the Aqaba-Dead Sea fault, and the Oceanographer Deep (Fig.17), seems to be in some way connected to the Brothers islands, localized and very close right west of the deep.

We have also produced a map of the Nereus Deep by merging the SEABEM data published by [Pautot (1983)] with the swaths we collected on the eastern flanks during the station approach, the brine sampling and the transit to N (Fig.(18). Since the SEABEAM data were apparently collected with a constant speed of sound of 1500 m/s, we tried to produce the best fit and applying the new function to the digitized contours, by

- converting the digitized data to msec (1500 m/sec)
- integrating on the depth interval the sound velocity profile measured during the CTD cast, to obtain an average value
- converting back to depth by applying the above average velocity function

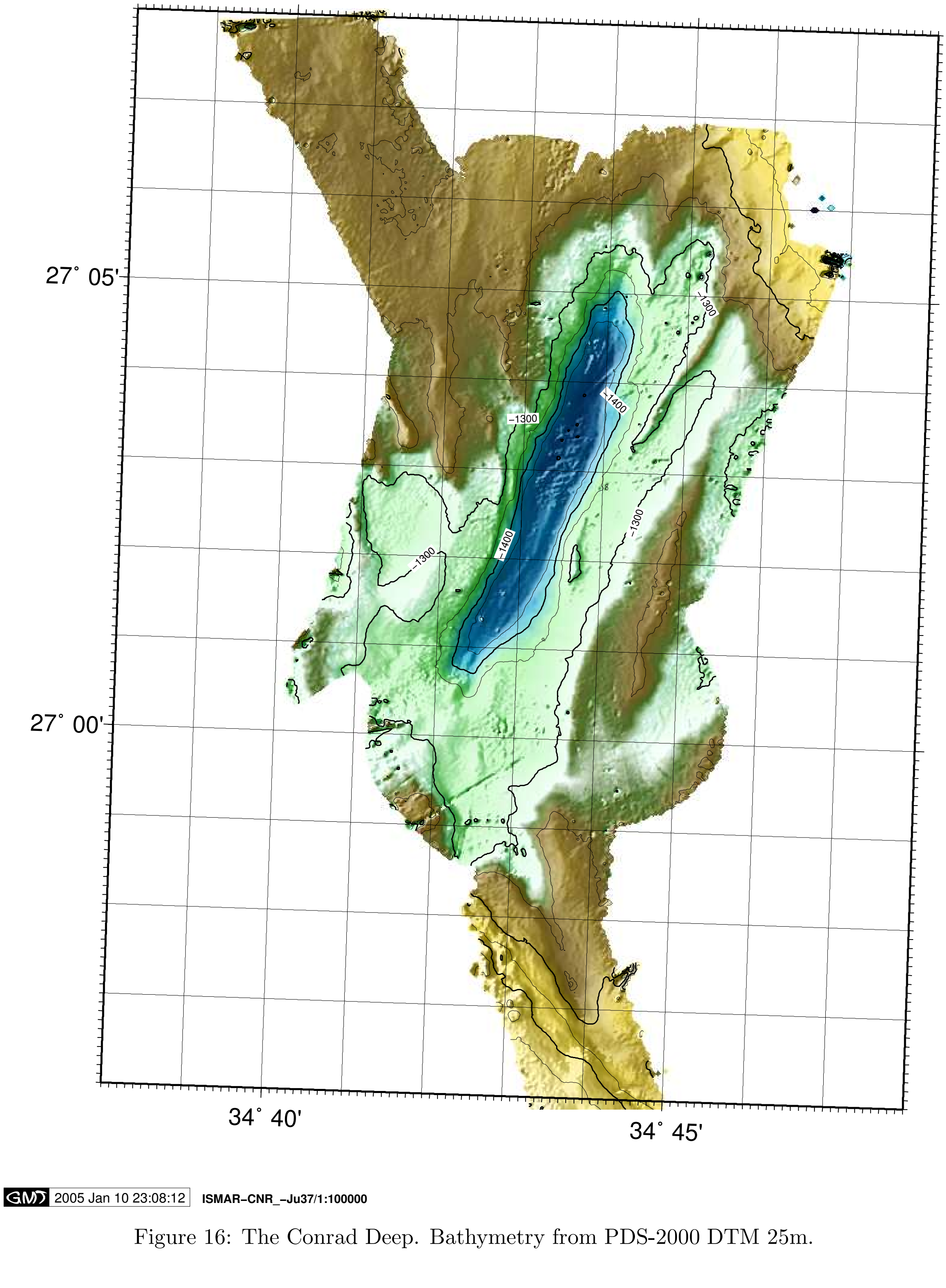

Figure 16: The Conrad Deep. Bathymetry from PDS-2000 DTM 25m.

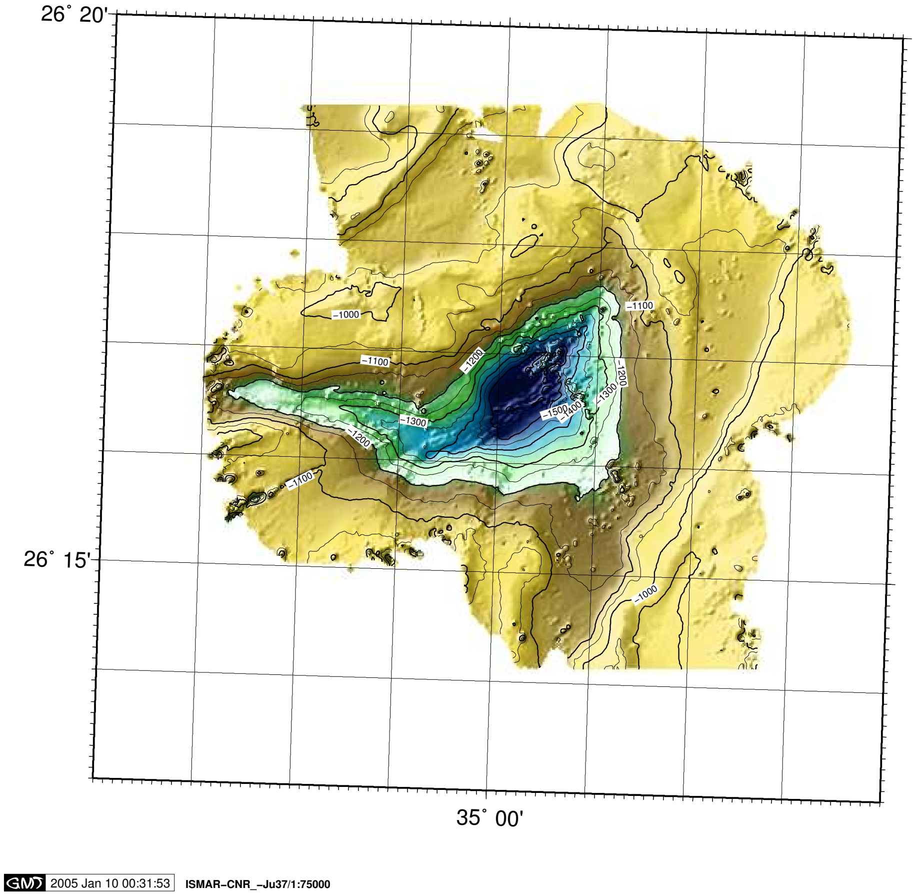

Figure 17: The Oceanographer Deep. Bathymetry from PDS-2000 DTM 25m.

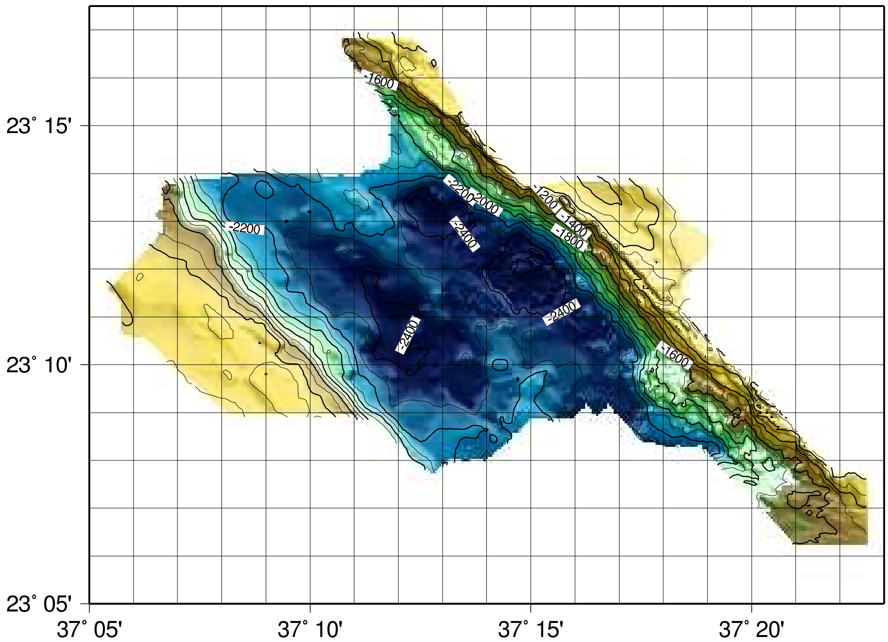

Figure 18: The Nereus Deep. Compilation with the data of [Pautot (1983)] and present survey.

5.2 SEABED SAMPLING

We focused mainly on dredging, with the aim to recover basalts and fresh volcanic materials. Additional sampling was performed by grab and gravity corer. The location and description of the samples are located in Tab.7.

Eleven sites were dredged for rock samples from submarine slopes and escarpments in and around the Thetis Deep. Two dredgers were lost during the operation. Four dredge samples contained basalts, while practically all other dredges contained abundant carbonate crusts. The carbonate crusts consist mostly of pteropods and foraminifera with little or no evidence for calcareous benthic organisms.

The basalts will be subjected to intense geochemical (major and trace elements, Nd, Sr, Os and other isotopes, water content, melt inclusions) and geochronological analyses, especially on the glasses of the pillows.

Some of the basalt samples show a thick crust of laminated authigenic carbonates, which will be analysed by isotopic methods and radiometric dating to provide an insight into the processes responsible for basalt emplacement.

Table 8 gives details on the rock description, subsampling and delivery. These samples will be analysed for standard geochemical and petrographic analysis.

Grab samples (GR01 to GR04) in the Main Trough to the west (outside) of the Thetys Deep, at depths between 700 and 800 m, revealed carbonate ooze and sands, rich in foraminifera and pteropods, with only little associated macrofauna (*Argonauta argo*, *Cuspidaria sp.*, etc.).

Grab GR05 at 1196 m water depth at the margin of the main Red Sea trough towards the 1600 m deep Conrad Basin reavealed very similar foram/pteropod ooze, pointing to a widely uniform sedimentation in the Main Trough above the axial valley and the aligned central deeps.

The gravity core at 750 m revealed a 3.3 m sequence of carbonate ooze, containing carbonate crusts. Further analyses (clay mineralogy, micropaleontology and geochemistry) will be taken out after cutting of the PVC-liner.

CRUISE RS05	R/V URANIA				
ID	DATE	LON	LAT	RECOVERY	LITHOLOGY
		ddmm.xxxx(E)	ddmm.xxxx(N)	Kg	
DR-01	2005-01-11	3737.2507	2237.8982	Bottom	
DR-01	2005-01-11	3736.8137	2237.5009	0.01	CCR-100%
DR-02	2005-01-11	3737.3711	2237.8701	Bottom	
DR-02	2005-01-11	3737.4949	2238.3749	200	CCR~100%;VG
DR-03	2005-01-11	3740.9743	2237.4635	Bottom	
DR-03	2005-01-11	3740.4707	2238.2590	80	BAS-100%
DR-04	2005-01-12	3756.9860	2214.8418	Bottom	
DR-04	2005-01-12	3756.8966	2215.0812	lost	-
DR-05	2005-01-13	3758.6531	2215.3196	Bottom	
DR-05	2005-01-13	3757.0000	2215.6667	0.1	CCR-100%
DR-06	2005-01-13	3757.6376	2215.1408	Bottom	
DR-06	2005-01-13	3757.5254	2215.7036	1.5	CCR-100%;DSC
DR-07	2005-01-13	3746.4602	2224.4240	Bottom	
DR-07	2005-01-13	3745.8987	2225.4049	100	CCR-99%;VG-1%
DR-08	2005-01-13	3744.6801	2225.4528	Bottom	
DR-08	2005-01-13	3744.5807	2226.3536	100	CCR-99%;BAS+VG-1%
DR-09	2005-01-13	3733.3787	2246.2928	Bottom	
DR-09	2005-01-14	3733.9083	2246.6215	lost	-
DR-10	2005-01-14	3734.4479	2245.4369	Bottom	
DR-10	2005-01-14	3734.4956	2246.4705	100	CCR-40%;BAS-60%
DR-11	2005-01-19	3649.7052	2349.2532	Bottom	
DR-11	2005-01-19	3649.1850	2350.0249	200	CM~100%;CCR+VS(?)
GR-01	2005-01-14	3743.9979	2318.7070	full	CM
GR-02	2005-01-14	3749.6070	2316.0934	full	CM
GR-03	2005-01-14	3753.3277	2310.9918	full	CM
GR-04	2005-01-14	3754.5438	2304.9869	full	CM
GR-05	2005-01-14	3443.7108	2707.3094	full	CM
CR-01	2005-01-	3759.0667	2259.7504	3.3m	CM-CCR(bottom)

Table 7: Samples location. DR*=dredges(start,end),GR*=grabs, CR*=core. CCR=Carbonate Crust, VG=Volcanic Glass, BAS=Basalt, DSC=Deep Sea Coral, VS=Volcanic Scoria, CM=Carbonate Mud.

Sample	Type	Size(cm)	Description	subsamples to
DR01-01	CCR	4x3x0.3	consolidated carbonate enriched in pteropods and forams. Layered.	ISMAR
DR02-01	VG	very small fragments	fresh basaltic glass	ISMAR
DR02-02	CCR	various size	consolidated carbonate enriched in pteropods and forams.	ISMAR-UR-SGS
DR03-01	BAS	30x15x20	moderately vesicular pillow basalt. Rare Plagioclase phenocrysts (1%) up to 1 cm in size. Vesicles are empty and up to 4mm in diameter. Fresh glassy crust up to 3 cm in thickness. Outer glassy surface of pillow is coated with thin Fe-Mn film. Interiorior fractures of pillow show a concentric alteration and are partly coated with Fe-Mn film.	ISMAR-UR-SGS-SCU
DR03-02	BAS	30x26x6	vesicular basalt (vesicles are empty and up to 0.5 cm in diameter), sheet flow. Very rare plagioclase phenocryst (up to 3mm). 1 cm thick glassy crust coated with thin Fe-Mn film. Outer surface is then coated with soft light-brown carbonatic sediment.	ISMAR-UR-SGS-SCU
DR03-03	BAS	25x24x9	vesicular basalt (vesicles are empty and 0.1-3 mm in diameter), sheet flow slightly fractured. Very rare plagioclase phenocryst (up to 3mm). 1 cm thick glassy crust. Thin Fe-Mn coat.	ISMAR-UR-SGS-SCU
DR03-04	BAS	20x20x5	same as 03-03, not fractured	ISMAR-UR-SGS-SCU
DR03-05	BAS	18x17x4	same as 03-04	ISMAR-UR
DR03-06	BAS	12x7x6	same as 03-04, but thin glassy crust	ISMAR-UR-SGS-SCU
DR03-07	BAS	10x7x4	same as 03-02 but 2 cm thick glassy crust	ISMAR-UR
DR03-08	BAS	4 pieces about 10x5x3	vesicular basalt similar to 03-02 with thin glassy crust and soft sediment encrusting the outer surface	ISMAR-UR-SGS-SCU
DR03-09	BAS	10x7x4	same as 03-07	ISMAR-UR
DR03-10	BAS	9x6x6	same as 03-06	ISMAR-UR-SGS-SCU
DR03-11	BAS	17x11x3	same as 03-02 but no fresh glass	UR
DR03-12	BAS	9 centimetric pieces	several pieces of lava flow, tabular with fresh glassy crust. Samples have been named with progressive letter A to I. A to ISMAR, B and C to UR, D to SGS, E to Egypt	ISMAR-UR-SGS-SCU
DR03-13	BAS	bag of several small pcs.	several pieces of lava flow, tabular with fresh glassy crust	
DR05-01	CCR	3 pieces	small fragments of pteropods-rich carbonate crusts	ISMAR-UR-SGS
DR06-01	CCR	various size		ISMAR-UR-SGS-SCU
DR07-01	VG	very small fragments	few small fragments of fresh basaltic glass	ISMAR
DR07-02	CCR	various size		ISMAR-UR-SGS
DR08-01	BS	15x10x8	slightly vesicular basalt with a 1 cm thick fresh glassy crust. The outer surface is covered by a 1 cm thick layered carbonate crust.	ISMAR-UR
DR08-02	VG	very small fragments	several small fragments of fresh basaltic glass	ISMAR
DR08-03	CCR	various size		ISMAR-UR-SGS
DR10-01	BAS	30x30x30	porphyric pillow basalt. Phenocrysts of Olivine up to 0.7 cm and Plagioclase up to 0.5 cm. Visible melt inclusions in both Ol and Plg. 1 to 2 cm. Rare very small vesicles. Thick glassy crust partly coated with a thin Fe-Mn crust.	ISMAR
DR10-02	BAS	22x16x11	slightly vesicular basalt with 0.5 to 1 cm thick fresh glassy crust. The basalt is moderately altered. The outer surface is covered with a thick carbonatic layer which looked crystallized calcite or aragonite. The carbonatic layer is itself covered with a $<$ 1 mm thick Fe-Mn crust. a smaller similar piece has been named 10-02b	ISMAR-UR
DR10-03	BAS	17x13x6	Plg-Ol poprhyric glassy basalt similar to 10-01 but tabular, either a sheet flow or the outer thick crust of a pillow .	ISMAR-UR-SGS-SCU
DR10-04	BAS	14x10x4	same as 10-03	ISMAR-UR-SGS-SCU
DR10-05	BAS	8x6x5	same as 10-01	ISMAR-UR
DR10-06	BAS	7x4x4	same as 10-01	ISMAR-UR
DR10-07	BAS	6x6x1.5	same as 10-03	ISMAR-UR
DR10-08	CCR	various size		ISMAR-UR-SGS
DR11-01	VS(?)	very small fragments		ISMAR
DR11-02	CCR	various size		ISMAR-UR-SGS

Table 8: Rock description, subsampling and destination. CCR=Carbonate Crust, VG=Volcanic Glass, BAS=Basalt, DSC=Deep Sea Coral, VS=Volcanic Scoria.

5.3 MAGNETOMETRY

The data were processed on board. The IGRF reduced data ranged from -900 to slightly above 1000 nT. Further processing will require the analysis of the closest observatory data. Figure 19 shows one day of data collected against the data of two INTERMAGNET observatories.

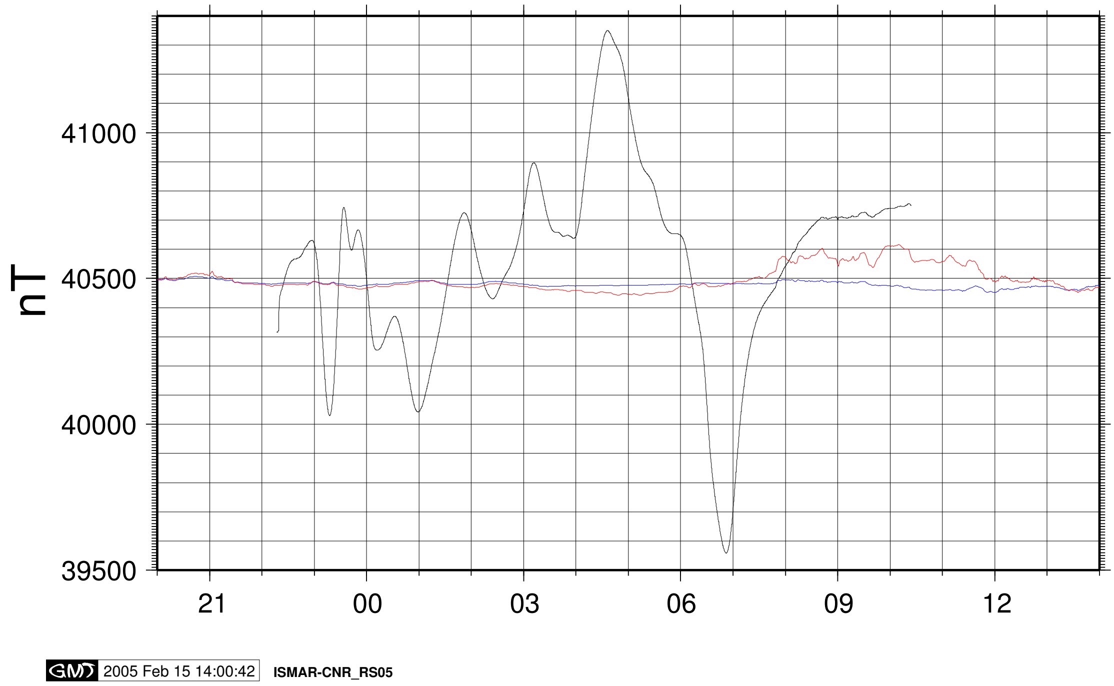

Figure 19: Example of the data collected during the cruise (median filtered, window 60 sec). Also shown the unfiltered data from the INTERMAGNET observatories of Addis Abeba (Ethiopia, long.38.77, alt.2400m), red line, and of Qsaybeh (Lebanon, long. 35.6, alt. 540m), blue line. The observatory data have been offset to the mean value of 40500 nT for comparison.

5.4 SBP

A quick processing with SEISPRO was made on board to improve the signal/noise ratio by applying a linear gain ranging from 1 to 5. Example of the recorded and processed data is shown in Fig.20.

The data ranged from good to acceptable. Chirp profiles show the first tens of meters of sedimentation (where sediments are present, especially outside the deeps), major evaporite mobilization, fault scarps, and oceanic-type seafloor, highlighted mainly in the deeps by many diffraction hyperbolae.

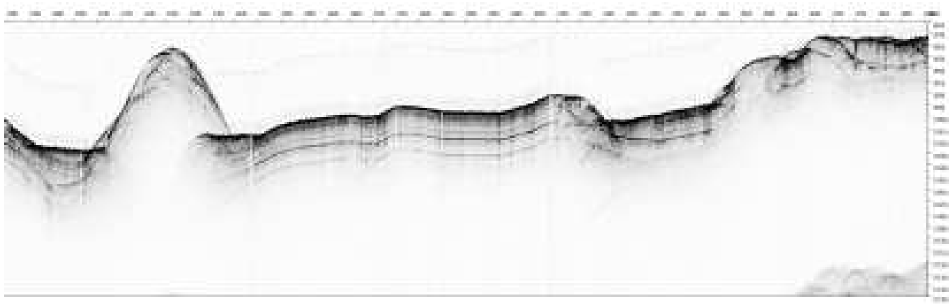

Figure 20: Example of SEISPRO SEG-Y SBP reprocessed data.

5.5 OCEANOGRAPHY

The CTD station descriptions are presented in Tab.4, whilst the more interesting CTD/XBT data are presented in Fig. 21.

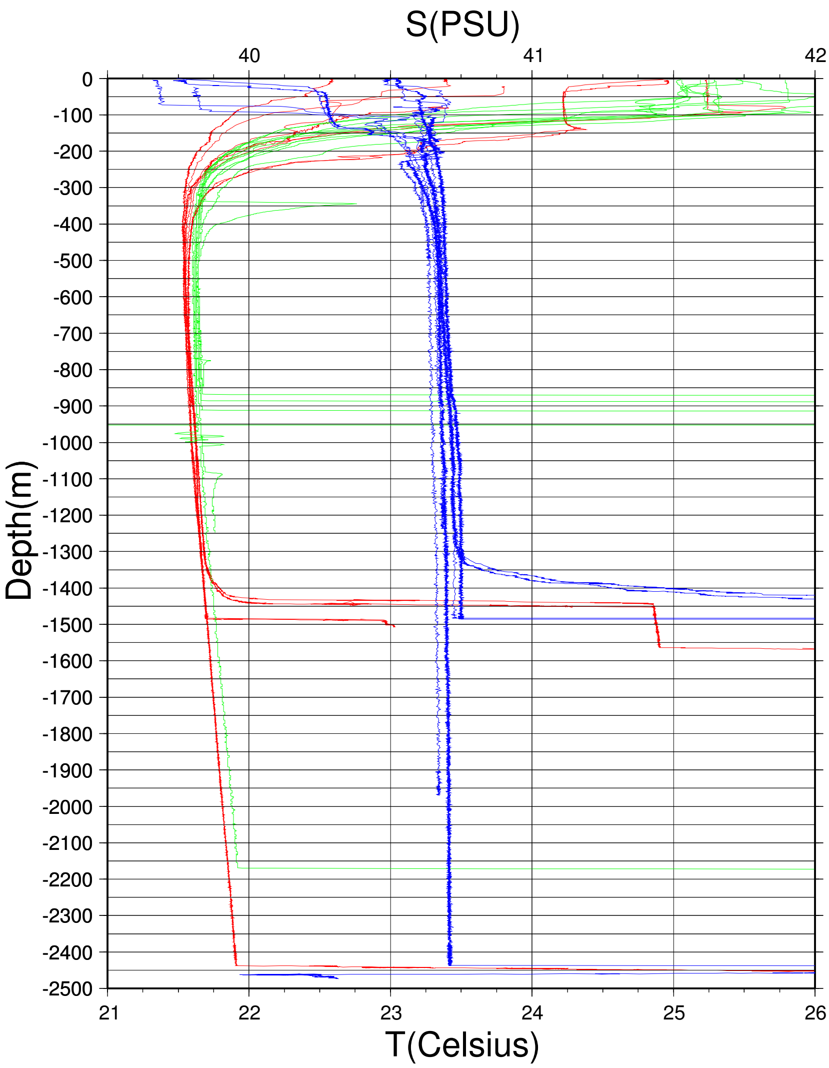

Figure 21: Temperature and Salinity plot of CTD (red, blue) and XBT (green) casts.

5.5.1 SURFACE TEMPERATURE AND SALINITY

The data recorded by the NAVPRO navigation system were used to produce maps of the surface temperature and salinity (at 3.5 m below the sea level). Figure 22 shows the results in the Thetis Deep area. These results, though at a low level of spatial and temporal synopticity, may be useful for oceanographic studies and for the reprocessing of the multibeam data set.

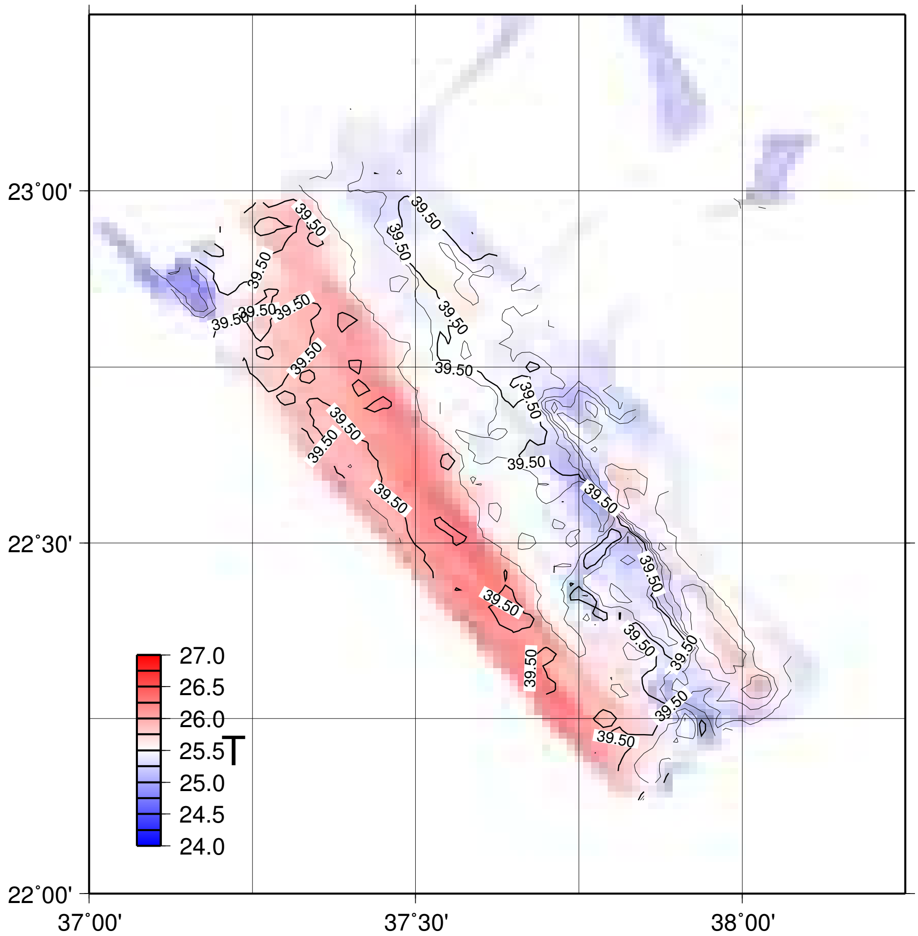

Figure 22: Surface temperature and salinity in the Thetis Deep. From 2005-01-07 to 2005-01-15. Salinity data corrected with the procedure explained in 4.2.2

5.5.2 WATER SAMPLING

Brine detection

A brine pool in the Conrad Deep (27N), first discovered by [Ehrhardt and Hubscher (2002)], was proven and could be identified by CTD-data (Stations 4, 5, and 12 in Tab.4). The brine pool is located at the center of the Conrad Deep with a maximum thickness of about 30 m (Fig.16). The sound velocity increases at 1485 m water depth from 1540 to 1780 m/s within a small interface of 1-2m (21). The temperature of the brine is 23.5° C. Light transmission signal is scattered within the brine/seawater interface of about 4 m probably reflecting particles precipitated or settled at the density and redox gradients.

The brine pool in the Oceanographer Deep is also located in the center of a depression at about 26N, E of the Brothers Islets. The thickness of the brine is about 100m and the brine/seawater interface is between 1432 and 1436m water depth. A temperature of 24.9°C and a sound velocity of 1803m/s were measured in the brine and the scattered light transmission was detected at the brine/seawater interface (CTD-6 and 11). A second small bottom near 26.5°C warm brine layer could be detected in the temperature and transmission profiles from CTD station 11.

Nereus Deep brine was detected at the north-east flank of a depression at stations CTD-9 and -10. The small brine pool shows less dense characteristics (Sound velocity 1780 m/s) and temperatures of 30°C are comparable to those found about 30 years before [Bignell and Ali (1976)].

The water column was investigated by CTD-measurements at two isolated depressions which are separated from the main basin in the Thetis Deep. No brine could be detected by CTD-measurement (CTD-7 and 8).

Hydrographic profiles

Hydrographic parameters of the water column in the central and northern Red Sea were determined during four hydrocast stations (Tab.4). Sound velocity (m/s), temperature (°C), and light transmission (%) were recorded with depth (pressure in dbar) from sea surface down to the seafloor with bottom contact (Fig.21). Northern Red Sea waters show a general decrease in temperatures from surface water temperatures (23.3-25.3°C) down to 21.7°C at about 200 m water depth. The measured temperature of 21.7°C of the Red Sea Deep Water is uniform down to the seafloor. However, if brines are present in depressions at the seafloor the temperature rises within a thin brine/seawater interface to higher temperatures in the brine. Surface waters are slightly warmer (24.3°C) in the central Red Sea at 22- 23N than in the Northern Red Sea between 26 and 27N (23.4-24°C). A prominent thick layer of less saline and cold water compared to the underlying water mass was detected in the Central Red Sea Area. The upper water mass is possibly derived from the north-heading current with waters from the Strait of Bab el Mandeb.

6 CONCLUSIONS

During a 14 days (of total 29 including transits) cruise in the Northern Red Sea we obtained:

1 high resolution bathymetric images and DTMs of the area

2 a detailed grid of high resolution CHIRP-SBP profiles to examine fault traces and sedimentary processes

3 across and along basin multichannel reflection seismic lines

4 bottom samples (dredges, grab, cores)

5 oceanographic data and water sampling, including brines

The data is under detail processing and analysis, and we expect to have new insights into the Red Sea geology and geochemistry.

No problem have to be reported about people and environment.

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